PROGRAM OF DOCTORAL STUDIES FORESTRY AND WOOD TECHNOLOGY

FIRST CREDIT GROUP – OBLIGATORY COURSES

1. GENERAL DATA			
1.1. Name of the course	Scientific research work methods	1.6. Course teacher(s)	Prof. Ružica Beljo Lučić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/ruzica-beljo-lucic/
1.3. Status of the course	obligatory course	1.8. Structure of teaching (number of hours: L + E + S)	5+10+5
1.4. No. of the course	1.	1.9. ECTS credits	4
1.5. Code of the course	DS1	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Introduce doctoral students to the process of scientific research, train them to independently formulate a research problem and plan experiments, and teach them to use the scientific style for writing scientific papers.		
2.2. Course contents (syllabus)	Basic principles, methodologies and techniques of scientific work. Organization of scientific work. Scientific system in the Republic of Croatia. Academic career in scientific research fields of forestry and wood technology. Academic positions. Library and information system of science. Scientific communication. Sources of scientific data. How to find scientific data. How to save and process scientific data. From inovation to patent and application. Protection of intellectual property. Scientific paper – from writing to publication in a journal. Scientific journal instructions to authors for writing the paper for publication. Conference papers. Posters. Evaluation of the scientific articles – revieweing process. Primary publications. Reference sources (secondary and tertiary) – databases. Citation of the scientific articles. Journal impact factor. Other bibliometric indicators for journals, articles and scientists. Where and what to research in forestry and wood technology. Searching scientific information through relevant scientific bases (Web of Science, Current Contens, Scopus).		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. present the organization of the scientific system and the ways of scientific communication 2. effectively search for sources of scientific information 3. independently formulate a research problem and set hypotheses 4. apply the rules of scientific writing style 5. evaluate scientific articles and projects 6. critically analyze bibliometric indicators of scientific publications		

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Silobrčić, V., 1994: Kako sastaviti, objaviti i ocjeniti znanstveno djelo. Medicinska naklada, Zagreb.
	S Day, R. A., 1998: How to write and publish a scientific paper. Oryx Press, Phoenix.
	Lukić, N., 1993: Metode i tehnika znanstvenog rada. Interna nerecenzirana skripta, 2. dop. izdanje. Šumarski fakultet, Zagreb.
	Wheatley, D. N., 2018: Scientific Writing and Publishing - A Comprehensive Manual for Authors, BioMedES Ltd UK
4.2. Additional literature	Glasman-Deal, H., 2010: Science Research Writing for Non-Native Speakers of English, Imperial College Press, London, UK.
	Kumar, R., 2011: Research methodology: a step-by-step guide for beginners, SAGE Publications Ltd, London, UK.
	Kirkman, J., 1994: Good style - writing for Science and technology. Rep.Ed.,E. & Fn Spon, London.

1. GENERAL DATA			
1.1. Name of the course	Design of experiment and statistical modelling	1.6. Course teacher(s)	Prof. Anamarija Jazbec, PhD Assoc. Prof. Mislav Vedriš, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/anamarija-jazbec/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/mislav-vedris/
1.6. Status of the course	obligatory course	1.8. Structure of teaching (number of hours: L + E + S)	5+10+5
1.7. No. of the course	2.	1.9. ECTS credits	4
1.8. Code of the course	DS2	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.4. Course objectives	The objective of the course is to learn students experiment planning procedures and to enable them to prepare the experiment, process, display, and analyse the data collected. Teach them about the possibilities of alternative interpretations of the same problem being examined in different ways, and have them present their experiment as well as the data analysis		
2.5. Course contents (syllabus)	Planning and implementation of field and laboratory experiments, especially in biotechnology - forestry and wood technology. Basic assumptions of design of experiment, sampling methods, treatment and observations, number of observations, experimental error and its reduction. Fixed and random effects. Random block design, Latin square, factorial experiments, nested experiments, "split plot" experiments. Determining the model of analysis of variance according to the design of the experiment. Interaction modelling. Multiple post hoc comparison methods. Repeated measure ANOVA (analysis of variance). Regression analysis. Model building methods. Choosing the best model. Model adequacy testing. Cluster analysis. Nonlinear models. Growth models		
2.6. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Plan and conduct your own research and collect data. 2. Conduct statistical data analysis. 3. Interpretation of the performed statistical data analysis.		

	4. Presentation of data analysis					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☐
	Experimental work	☒	Report	☒	**Presentation**	☒
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Jazbec, A., 2020: Priručnik iz planiranja pokusa. Interna skripta.					
	Sokal, R. R., F. J. Rohlf, 1995: Biometry, Freeman and Company, New York					
	Zar, J. H., 2010: Biostatistical Analysis, 5th ed., Prentice Hall International, New Jersey.					
4.2. Additional literature	Winer, B. J., D. R. Brown, K, M. Michels, 1991: Statistical Principles in Experimental Design, 3rd ed, Mc Graw Hill Boston					
	McGarigal, K., S. Cushman, S. Stafford, 2000: Multivariate Statistics for Wildlife and Ecology Research, Springer, New York.					
	Tabachnick, B. G., L. S. Fidell, 2001: Using Multivariate Statistics, Allyn and Bacon, Boston.					
	Conover W.J., 1998: Practical nonparametric Statistics, John Wiley&Sons, New York.					
	Montgomery D.C., 2009: Introduction to Statistical Quality Control, 6th ed., Wiley&Sons, New York					

SECOND CREDIT GROUP – COURSES OF THE MODULES

1. GENERAL DATA			
1.1. Name of the course	Close to nature silviculture	1.6. Course teacher(s)	Prof. Igor Anić, PhD Ass. Prof. Stjepan Mikac, PhD
1.2. Name of the module (if applicable)	Silviculture	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/igor-anic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/stjepan-mikac/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	12+14+6
1.4. No. of the course	3	1.9. ECTS credits	7
1.5. Code of the course	DSU 5	1.10. Language(s)	Croatian X English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	To train a student for: 1. scientific research and practical activity in the field of close to nature silviculture, 2. comparative analysis of research results and practical examples of the close to nature silviculture, 3. analysis of the main types of Central European virgin forests and silvidynamic processes, 4. application of the close to nature silviculture concept in the forest management practice.		
2.2. Course contents (syllabus)	The concept of a close to nature silviculture approach in theory and practice. The concept, origin and dynamics of natural forest (silvigenesis and silvidynamics). Comparative analysis of the structure and texture of virgin forests in Central Europe. Research methods in virgin forests. Some results of virgin forests research and possibilities of application in the close to nature silviculture. Different strategies, programs and forms of forest management in accordance with natural principles. Comparative analysis of virgin forests and forests managed according to natural principles. Analysis of natural regeneration at the forest boundary, on bare forest land, after deforestation and under the canopy. Relationship of canopy gap, light and natural regeneration. Influence of regeneration area size on natural regeneration and development of young growth. Methods of conversion in close to nature silvicuture concept: application in practice, research methods, ecological and economic effects. Access to degradation forms of forests in the Mediterranean area. Pioneer and transitional tree species in the concept of close to nature silviculture. Influence of natural and silvicultural selection of trees on stand structure. Criteria		

	and indicators of sustainable forest management. Application of the principles of the Pro Silva Association in forest management. Adaptation of close to nature silviculture in the conditions of climate change and natural disasters.					
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. present model of close to nature silvicuture scientific research, 2. present examples of close to nature silviculture practice, 3. compare the main types of Central European virgin forests, 4. compare silvidynamic processes in the main types of Central European virgin forests, 5. predict silvidynamic processes in natural stands, 6. recommend close to nature silvicultural treatment, 7. recommend silvicultural treatment in changed stand and site conditions.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Anić, I. (gl. ur), 2020: Gospodarenje šumama u uvjetima klimatskih promjena i prirodnih nepogoda. Zbornik radova sa					
	Matić, S., I. Anić (ur.), 2009: Prašumski ekosustavi dinarskoga krša i prirodno gospodarenje šumama u Hrvatskoj. Zbornik					
	Saniga, M., 2013: Natural forest ecosystems, structure and methodological procedures of research. TU Zvolen, Zvolen, 116 p.					
	Saniga, M., S. Kucbel, 2013: Close to nature silviculture. TU Zvolen, Zvolen, 97 p.					
4.2. Additional literature	Klepac, D. (ur.), 1996: Hrast lužnjak (Quercus robur L.) u Hrvatskoj. HAZU i Hrvatske šume p.o. Zagreb, Vinkovci – Zagreb, 559					
	Leibundgut, H., 1982: Europaeishe Urwaelder der Bergstufe. Verlag Paul Haupt, Bern – Stuttgart, 306 s.					
	Matić, S. (ur.), 2011: Šume hrvatskoga Sredozemlja. Akademija šumarskih znanosti, Zagreb, 740 s.					
	Matić, S. (ur.), 2003: Obična bukva (Fagus sylvatica L.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 855 s.					
	Matthews, D. J., 1989: Silvicultural systems. Oxford Science publications, 284 s.					

	Prpić, B. (ur.), 2001: Obična jela (Abies alba Mill.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 895 str.
	Vukelić, J. (ur.), 2005: Poplavne šume u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 455 s.
	+ selected scientific articles according to the special preferences of each student (maximum 10 articles)

1. GENERAL DATA			
1.1. Name of the course	Forest establishment	1.6. Course teacher(s)	Prof. Milan Oršanić, PhD Assoc. Prof. Damir Drvodelić, PhD Assist. Prof. Vinko Paulić, PhD
1.2. Name of the module (if applicable)	Silviculture	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/milan-orsanic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/damir-drvodelic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/vinko-paulic/
1.3. Status of the course	obligatory course	1.8. Structure of teaching (number of hours: L + E + S)	12+14+6
1.4. No. of the course	4	1.9. ECTS credits	7
1.5. Code of the course	DSU4	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to acquire knowledge in the field of forest seed production necessary for mastering the technology of forest seedling production as well as raising new forest stands. By mastering the set tasks, complex knowledge from the ecology and biology of species, establishment technology as well as the maintenance of new forest plantations is acquired.		
2.2. Course contents (syllabus)	The establishment of forests would include the knowledge needed to raise and care for new forest areas. The subject would be designed to cover the area of forest seed production, nursery and the establishment of new forests. In the field of forest seed production, students are introduced to the structure of forest seeds, types of forest seeds, chemical composition, physiological prerequisites for fruiting, harvesting and handling of seeds, processing and testing the quality of seeds. In a special part, the seeds of the main forest genera would be processed, from the point of view of structure, fruiting, collection, morphological characteristics, storage, etc. In the field of forest nurseries, special attention would be given to site selection , methods of growing seedlings (bare root, container seedlings), basics of tillage and fertilization (types of fertilizers),		

	extraction and packaging of seedlings, shipment of seedlings, legal regulations and management in nursery. In a special part, the nursery production of the main types of forest trees would be processed. In the field of afforestation and raising forest plantations, we would like to look at the history of afforestation in Croatia and in the world, reasons for raising plantations and world trends, advantages and disadvantages of plantations, choice of afforestation species, number of plants, methods of establishment, sowing and planting time, weed control , care, pruning, rotation of species, establishement of plantations for special purposes (biomass, windbreaks, Christmas trees, etc.).
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. synthesis of content from the structure and biology of forest seeds for writing reports and seminar papers 2. test the elements of forest seed quality according to international rules (ISTA) 3. compare the technology of nursery production of seedlings of the main commercial species of forest trees 4. assess the morphological and physiological quality of forest seedlings of the main commercial species of forest trees 5. anticipate the choice of tree species and provenances for forest establishment 6. write a detailed design for establishment of a new forest plantations

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Chapman, G. A., R. D. Wray, 1987: Christmas Trees for Pleasure and Profit. Rutgers University Press. Third Edition.
	Davidson, H., R. Mecklenburg, 2000: Nursery Management. Prentice Hall.
	Krüssmann, G., 1997: Die Baumscuhule. Paul Parey Verlag.
	Oršanić, M., I. Anić, D. Drvodelić, 2005: Šumsko sjemenarstvo i rasadničarstvo. Šumarski fakultet Sveučilišta u Zagrebu, interna skripta, Zagreb, 228 s.

	Oršanić, M., I. Anić, D. Drvodelić, 2005: Priručnik za razmnožavanje drveća i grmlja. Šumarski fakultet Sveučilišta u Zagrebu, interna skripta, Zagreb, 125 s.
	Oršanić, M., Anić, I., Drvodelić, D., 2005: Šumske kulture i plantaže. Šumarski fakultet Sveučilišta u Zagrebu, interna skripta, Zagreb, 115 s.
4.2. Additional literature	Savill, P. E., Auclair, J., Falck, D. J., 1997: Plantation Silviculture in Europe. Oxford University Press.
	Suszka, B., C. Muller, M. Bonnnet-Masimbert 1996: Seeds of forest broadleaves from harvest to sowing, INRA Paris, 295 p.

1. GENERAL DATA			
1.1. Name of the course	Forest Tree Breeding	1.6. Course teacher(s)	Prof. Saša Bogdan, PhD Assist. Prof. Ida Katičić Bogdan, PhD
1.2. Name of the module (if applicable)	Forest Tree Breeding	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/sasa-bogdan/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ida-katicic-bogdan/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	5 + 14 + 5
1.4. No. of the course	5	1.9. ECTS credits	7
1.5. Code of the course	DSU3	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) to give students an insight into the theory of forest tree breeding; 2) to train students to design and implement a classic program of forest tree breeding; 3) to train students to apply knowledge in the field of genetics in forest management.		
2.2. Course contents (syllabus)	Depending on prior knowledge and needs, students can acquire basic knowledge in the field of forest tree breeding: (Polygenic inheritance, quantitative traits and environment; Modifications, mutations, extranuclear inheritance; Basics of forest tree species breeding; Woody species cloning techniques; Initial plant breeding cycle, Breeding population; Mass selection methods. Selected population; Reproductive and breeding populations; Genotypic selection based on genetic testing; Development of breeding strategy; Controlled crossbreeding; Design and techniques; Breeding by hybridization (intraspecific and interspecies breeding); Breeding for resistance to biotic factors; Methods of macropropagation and micropropagation in forest tree breeding; Methods of biotechnology in tree improvement). However, students can acquire upgraded knowledge that accompanies the development of professional and scientific achievements in the field and narrower and specific current issues (eg specific methodology of using DNA markers in forest tree breeding; methodology of genetic testing; recent methods of biotechnology in breeding etc.)		

2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. To explain the process of classical breeding, methods of selection of woody species; Select suitable candidates in the process of mass selection; Evaluate individual candidates and select plus individuals. 2. To explain the process of genetic testing plus individuals and the selection of elite individuals; Select elite individuals based on genetic testing results. 3. To choose an option and devise a plan for controlled crossing of elite individuals. 4. To design mass production of genetically improved varieties. 5. To synthesize existing knowledge about the genetic diversity of a specific species of forest trees. 6. To evaluate and select the appropriate breeding methodology for the specific case.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	White, T. L., W. T. Adams, D. B. Neale, 2007: Forest Genetics. Wallingford, UK, Cambridge, CAB International. p682.					
	Namkoong, G., Kang, H. C., Brouard, J. S.: TREE BREEDING PRINCIPLES AND STRATEGIES, Springer Verlag, 1988, 345 str.					
4.2. Additional literature	Selected scientific articles suitable for the specific needs of the student.					

1. GENERAL DATA			
1.1. Name of the course	Applied Dendrology	1.6. Course teacher(s)	Prof. Marilena Idžojtić, PhD Assist. Prof. Igor Poljak, PhD
1.2. Name of the module (if applicable)	Forest Tree Breeding	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/marilena-idzojtic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/igor-poljak/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	12 + 8 + 10
1.4. No. of the course	6	1.9. ECTS credits	7
1.5. Code of the course	DSU2	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	Students acquire theoretical and practical knowledge about autochthonous and allochthonous tree and shrub species important for Croatian forestry due to wood production as well as as use of fruits or some other plant parts. They also aquire theoretical and practical knowledge about potentially important woody species which potential has not been used enough or it has not been used at all. Theoretical knowledge encompasses biological features, morphological characteristics, distribution and the economical importance of species. Students acquire practical skills to recognize woody species on the basis of different morphological characteristics. They also gain knowledge on the practical use of woody species in forestry.		
2.2. Course contents (syllabus)	The economical importance, morphological characteristics and natural range of particular species and genera of gymnosperms and angiosperms. The subject covers autochthonous and allochthonous tree and shrub species important for Croatian forestry due to wood production as well as use of fruits or some other plant parts. The subject also covers potentially important woody species (particular plant parts could be used for different purposes, or a whole plants could be used for specific purpose), but which potential has not been used enough or it has not been used at all. The genera belong to the following families: Ginkgoaceae, Pinaceae, Taxodiaceae, Cupressaceae, Taxaceae, Lauraceae, Ranunculaceae, Berberidaceae, Ulmaceae, Moraceae, Juglandaceae, Fagaceae, Betulaceae, Chenopodiaceae, Actinidiaceae, Tiliaceae, Malvaceae, Cistaceae, Tamaricaceae, Passifloraceae, Salicaceae, Capparidaceae, Ericaceae, Ebenaceae, Styracaceae, Grossulariaceae, Rosaceae, Fabaceae, Elaeagnaceae, Myrtaceae, Punicaceae, Nyssaceae, Cornaceae, Aquifoliaceae, Rhamnaceae, Vitaceae, Hippocastanaceae, Aceraceae, Simaroubaceae, Meliaceae, Rutaceae, Lamiaceae, Oleaceae and Caprifoliaceae. The topics of the lectures follow a systematic order.		

2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Describe autochthonous and allochthonous woody species according to different morphological characteristics. 2. Analyze autochthonous and allochthonous woody species according to economic importance and use. 3. Recognize the possibility of using autochthonous woody species that are underutilized. 4. Recognize the possibility of using new allochthonous woody species. 5. Select and recommend autochthonous and allochthonous woody species for different purposes in forestry.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☒		
4. LITERATURE LIST						
4.1. Obligatory literature	Idžojtić, M., 2005: Listopadno drveće i grmlje u zimskom razdoblju. Šumarski fakultet Sveučilišta u Zagrebu. 256 pp.					
	Idžojtić, M., 2009: Dendrologija – List. Šumarski fakultet Sveučilišta u Zagrebu. 904 pp.					
	Idžojtić, M., 2013: Dendrologija – Cvijet, češer, plod, sjeme. Šumarski fakultet Sveučilišta u Zagrebu. 672 pp.					
	Šumarska enciklopedija Vol. I-III, 1980-1987. JLZ Miroslav Krleža, Zagreb.					
4.2. Additional literature	Duarte, O., Paull, R.E., 2015. Exotic fruits and nuts of the New World. CABI, Wallingford.					
	Farjon, A., 2010. A handbook of the world's conifers. Vol. I-II. Brill, Leiden.					
	Hu, S., 2005. Food plants of China. The Chinese University Press, Hong Kong.					
	Janick, J., Paull, R.E., 2008. The encyclopedia of fruits and nuts. CABI International, London.					
	Krüssmann, G., 1972: Handbuch der Nadelgehölze. Verlag Paul Parey, Berlin und Hamburg.					
	Krüssmann, G., 1976: Handbuch der Laubgehölze. Band I-III. Verlag Paul Parey, Berlin und Hamburg.					
	Louppe, D., Oteng-Amoako, A.A., Brink, M. (Eds.), 2008. Plant resources of tropical Africa 7(1). Timbers 1. PROTA Foundation,					
	Morton, J., 1987: Fruits of warm climates. Florida Flair Books.					

1. GENERAL DATA			
1.1. Name of the course	Applied forest phytocenology	1.6. Course teacher(s)	prof. Dario Baričević, PhD, prof. Joso Vukelić, PhD professor emeritus
1.2. Name of the module (if applicable)	Forest vegetation and habitats	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/dario-baricevic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	10 + 10 + 8
1.4. No. of the course	7	1.9. ECTS credits	7
1.5. Code of the course	DSU9	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1. through real examples from practice to acquaint students with the application of phytocenological knowledge in the management, governance and protection of forest ecosystems 2. to train students for independent phytocenological recording, processing and interpretation of phytocenological data, as well as creation of vegetation maps and interpretation of the same 3. to enable students to use the latest knowledge, methods and tools, and apply them when making and interpreting the basics of management, management plans, ecological studies and spatial plans		
2.2. Course contents (syllabus)	Preparation and collection of data; phytocoenological recording. Examples of use in practice. Classical analysis of phytocenological records; characteristic and distinguish species, process of synthetic classification. Examples of use in practice. Computer processing of phytocenological records. Computer software in forest phytocenology - types, ways of use, advantages. Turboveg database. Examples of use in practice. Computer programs for data analysis in ecology and systematics. Syntax 2000 programming package, Juice programming package; description, possibilities, advantages. Examples of use in practice. Floral composition as an indicator of the state of forest ecosystems. Examples from practice. Mapping vegetation; in general, the meaning of vegetation maps, types and scale of maps. Examples of use in practice.		

	Modern methods of vegetation research and mapping and their application. Advantages and disadvantages compared to classical methods. Examples of use in practice. Digitized vegetation maps - importance and advantages in relation to classic vegetation maps. Application in the preparation of the management bases, management plans, ecological studies and similar. Application of phytocenological research and knowledge in the making and interpretation of management bases, management plans, ecological studies and spatial plans. Examples of use in practice.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Operate and use modern databases and computer programs for analysis and interpretation of phytocenological data. 2. Valorize the floral composition as an indicator of the state of forest ecosystems. 3. Operate and use modern methods and tools for mapping forest vegetation. 4. Interpret forest vegetation maps and apply them in practice. 5. Explain the application of phytocenological research and knowledge in the making and interpretation of management bases, management plans, ecological studies and spatial plans. 6. Critically discuss read scientific articles with colleagues and apply them in practice.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Vukelić, J., Đ. Rauš, 1998: Šumarska fitocenologija i šumske zajednice u Hrvatskoj. Udžbenik, Sveučilište u Zagrebu, Šumarski fakultet, Zagreb, 310 str.
	Vukelić, J., Mikac, S., Baričević, D., Bakšić, D., R. Rosavec, 2008: Šumska staništa i šumske zajednice u Hrvatskoj Nacionalna ekološka mreža. Državni zavod za zaštitu prirode, 263 str.
	PowerPoint presentations with examples of application of forest phytocenology in practice
4.2. Additional literature	Podani, J., 1994: Multivariate data analysis in Ecology and Systematics. SPB Academic Publishing bv. Den Haag.

Ellenberg, H., 1979: Zeigerwerte der Gefässpflanzen Mitteleuropas. Verlag E. Goltze KG, Göttingen.
Baričević, D., 1998: Ecological-vegetational properties of forest “Žutica”. Glas. šum. pokuse 35: 1–91.
Baričević, D., 2006: Promjene flornoga sastava šumskih zajednica na lokalitetima naftnih akciditeta u šumi Žutica. Naftaplin, knjiga 20/06: 107-125.
Baričević, D., N. Pernar, J. Vukelić, S. Mikac & D. Bakšić, 2009: Floristic composition as an indicator of destabilisation of lowland forest ecosystems in Posavina. Periodicum Biologorum 111(4): 443-451.
Šapić, I., Vukelić, J., Mikac, S., Baričević, D., 2015: Mapping of forest vegetation of Plitvice Lakes National Park using SPOT satellite images. Poster. U. 36th Meeting of Eastern Alpine and Dinaric Society for Vegetation Ecology - Book of Abstracts.
Zenković, D., 2015: Promjene flornoga sastava na lokalitetima narušenosti u šumi Žutica, diplomski rad, Šumarski fakultet Sveučilišta u Zagrebu.
Vukelić, J. i suradnici, 2005: Studija uređenja područja Bundeka. Gradski ured za poljoprivredu i šumarstvo i Šumarski fakultet.

1. GENERAL DATA			
1.1. Name of the course	INTERACTION OF SITE - PLANT IN FORESTRY	1.6. Course teacher(s)	prof. Nikola Pernar, PhD prof. Ivica Tikvić, PhD prof. Željko Škvorc, PhD
1.2. Name of the module (if applicable)	FOREST VEGETATION AND SITES	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/nikola-pernar/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ivica-tikvic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/zeljko-skvorc/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	12 + 12 + 6
1.4. No. of the course	8	1.9. ECTS credits	7
1.5. Code of the course	DSU15	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to develop the knowledge necessary for the evaluation and implementation of multidisciplinary research in the relationship between habitat and plant. The significance and role of individual elements of habitats important for the integration of such knowledge into models of plant functioning in a specific habitat are analyzed. Critical thinking skills and skills in independent design, implementation and analysis of experiments are developed.		
2.2. Course contents (syllabus)	Fundamentals and characteristic relationships of habitats and plants in the forest ecosystem. Soil fertility. Physical and chemical properties of soil. The nutrient cycle in the soil-plant system. Water in the soil. Influence of environmental factors (light, temperature, concentration of carbon dioxide, water, mineral nutrients, etc.) on physiological processes in forest trees (photosynthesis, transpiration, respiration, growth, etc.). Mycorrhiza. Root ecology.		
2.3. Expected learning outcomes at the level of	1. Explain the relationship between stress physiology and soil nutrient status. 2. Present the possibilities of monitoring water in the soil in order to optimize the realization of its fertility.		

the course (4 to 7 learning outcomes)	3. Design research and design experiments related to the influence of environmental factors on the physiological processes of forest trees. 4. To correctly interpret the results of scientific research in the field of ecophysiology of forest trees.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Pernar, N., 2017: Tlo; nastanak, značajke, gospodarenje. Šumarski fakultet Sveučilišta u Zagrebu, 799 p.					
	Marschner, P. 2012: Mineral nutrition of higher plants. Elsevier A. P.					
	Lambers, H., Oliveira, R.S. 2019: Plant Physiological Ecology. Springer International.					
4.2. Additional literature	Kirkham, M. B., 2005: Principles of soil and plant water relations. Elsevier A. P., 500 p.					
	Aroca, R., 2012: Plant Responses to Drought Stress From Morphological to Molecular Features. Springer.					
	Smith, S. E., Read, D. J., 1997: Mycorrhizal Symbiosis, Academic Press, ISBN 0-12-652840-3, str. 1-589.					
	+ selected scientific articles (maximum 10 articles)					

1. GENERAL DATA			
1.1. Name of the course	Silviculture in conditions of forest dieback	1.6. Course teacher(s)	Prof. Igor Anić, PhD Prof. Ivica Tikvić, PhD
1.2. Name of the module (if applicable)	Forest revitalization and remediation of degraded habitats	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/igor-anic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/ivica-tikvic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	10+8+6
1.4. No. of the course	9	1.9. ECTS credits	7
1.5. Code of the course	DSU 6	1.10. Language(s)	Croatian X English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	To train students to act in cases of forest stand decline and extraordinary tree dieback and to assess, identify the causes, analyze the consequences, make decisions on the implementation of silvicultural procedures and planning, implementation and control of procedures.		
2.2. Course contents (syllabus)	Silvicultural view on the causes and consequences of forest stand decline and tree dieback. Anthropogenic influences. Impact of climate change. Impact of water regime change. Analysis of other indirect and direct impacts. Analysis of examples of dieback in lowland forest complexes, hill forests, mountain forests, high-mountain forests and in the Mediterranean area. Methods of silvicultural and ecological research and monitoring of dieback. Ecological approach in remediation of stands and habitats. Regeneration of stands affected by dieback. Use of pioneer and transitional tree species. Influence of biological site preparation. Tending of stands in conditions of dieback of trees. Silvicultural plan. Silvicultural procedures in cases of dieback of trees in softwood and hardwood floodplain forests. Silvicultural procedures in cases of dieback of pedunculate oak trees. Silvicultural procedures in cases of dieback of sessile oak trees. Silvicultural procedures in cases of dieback of european beech trees. Silvicultural procedures in cases of dieback of european fir trees. Causes and consequences of forest degradation in continental and Mediterranean areas. Natural and artificial (anthropogenic) site and stand degradation. Silvicultural practices in degraded forests. Forest conversion.		
2.3. Expected learning outcomes at the level of	1. Determine the causes and consequences of forest stands decline and dieback of trees.		

the course (4 to 7 learning outcomes)	2. Prepare a report on dieback in lowland forest complexes, hilly forests, mountain forests, high-mountain forests and in the Mediterranean area. 3. Propose methods of silvicultural and ecological research and monitoring in conditions of forest stand decline and dieback of forest trees. 4. Recommend silvicultural procedures in dieback conditions. 5. Compile a silvicultural plan for biological remediation of stands and habitats. 6. Compile a silvicultural plan for the conversion of degraded forest stands.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Anić, I. (gl. ur), 2020: Gospodarenje šumama u uvjetima klimatskih promjena i prirodnih nepogoda. Zbornik radova sa					
	Klepac, D. (gl. ur.), 1996: Hrast lužnjak (Quercus robur L.) u Hrvatskoj. Centar za znanstveni rad HAZU u Vinkovcima i Hrvatske					
	Matić, S. (gl. ur.), 2011: Šume hrvatskoga Sredozemlja. Akademija šumarskih znanosti, Zagreb, 740 str.					
	Matić, S. (gl. ur), 2003: Obična bukva (Fagus sylvatica L.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 855 str.					
	Prpić, B. (gl. ur.), 2001: Obična jela (Abies alba Mill.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 895 str.					
	Vukelić, J. (gl. ur), 2005: Poplavne šume u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 455 str.					
4.2. Additional literature	Tikvić, I. (ur.), 2018: Branimir Prpić - Ekologija šuma i šumarstvo. Hrvatsko šumarsko društvo i Sveučilište u Zagrebu, Šumarski					
	+ selected scientific articles according to the special preferences of each student (maximum 10 articles)					

1. GENERAL DATA			
1.1. Name of the course	Revitalization of burned areas	1.6. Course teacher(s)	Prof. Željko Španjol, Ph.D. Prof. Damir Barčić, Ph.D. Assoc. Prof. Roman Rosavec, Ph.D.
1.2. Name of the module (if applicable)	Forest revitalization and remediation of degraded habitats	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/zeljko-spanjol/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/damir-barcic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/roman-rosavec/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	8+10+6
1.4. No. of the course	10	1.9. ECTS credits	7
1.5. Code of the course	DSU8	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	Frequency of open fires, impact of habitat conditions (geological structure, relief, soil, vegetation), biological-ecological, landscape and economic damage and knowledge of the characteristics of forest fuels primarily their flammability, flammability and moisture content. Methods of restoration and remediation of burned areas (type selection and costs).		
2.2. Course contents (syllabus)	Types of open space fires. Classifications based on various factors. Potential forest fuel - classification, flammability, combustibility, moisture content, field presence, its impact on the occurrence and spread of open space fires. Relationship of climate conditions to open space fires. Knowledge of meteorology in the problem of open space fires. Vegetation cover and categories of its endangerment. Methodology of forest and non-forest habitat restoration.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Identify the key factors in the occurrence of open space fires, types of fires, summarize and relate the importance of the factors of occurrence.		

	2. Analysis and interpretation of flammability, flammability and moisture content factors. Get acquainted with the models of forest fire risk assessment 3. Describe and explain firefighting techniques, preventive measures and the application of fire protection systems. 4. Analysis and assessment of the intensity of ecological and economic damage to forest vegetation.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Španjol,Ž., Barčić, D., 2020: Šumski požari i poslijepožarna obnova vegetacije. Fakultet šumarstva i drvne tehnologije. Zagreb.					
	Moreira, F., Arianoutsou, M., Corona, P., De las Heras, J. 2012: Post-Fire Management and Restoration of Southern European					
4.2. Additional literature	Španjol, Ž., Barčić, D., Rosavec, R., Mandić, A., Vučetić, M (2006): Procjena ugroženosti mediteranskih šuma od požara					
	Vučetić, M, Španjol, Ž. & Barčić, D. 2002: Prirodna obilježja i potencijalna opasnost od šumskih požara., 169-183. Zbornik					
	Španjol, Ž, Barčić, D. (2001): Biološka sanacija šumskih požara u sastojinama crnog bora (Pinus nigra Arnold) . Znanost u					
	Španjol, Ž., Biljaković, K., Rosavec, R., Dominko, D., Barčić, D., Starešinić, D. (2008): Šumski požari i fizikalni modeli. Šumarski					
	Thomas, P.A. McAlpine, R.S. 2010: Fire in the Forest. Cambridge University Press, 225.					

1. GENERAL DATA			
1.1. Name of the course	SYSTEMS OF SOIL CLASSIFICATION	1.6. Course teacher(s)	Prof. Nikola Pernar, PhD Prof. Darko Bakšić, PhD
1.2. Name of the module (if applicable)	FOREST SOILS	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/nikola-pernar/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/darko-baksic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	10 + 10 + 10
1.4. No. of the course	11	1.9. ECTS credits	7
1.5. Code of the course	DSU12	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to introduce the student to the field of soil classification systems in order to understand the correspondence of different national and regional soil classifications in the world. Knowledge of the most important classification systems is necessary for the use and development of environmental information systems, for understanding the terms when using literature, professional and scientific, and for professional and scientific communication (international projects, publication of papers, etc.).		
2.2. Course contents (syllabus)	Development of soil classification. Development and features of European classifications. Soil classification in Croatia - development, condition, perspective. Development and features of soil classification in the United States. Pedotaxonomic categories in the U.S. classification system. FAO-UNESCO legend of the soil map of the world and WRB-classification. World reference base for soil. Diagnostic horizons. Diagnostic properties and diagnostic material. The key to describing the main soil groups. Soil classification in Croatia and the relationship with the WRB classification.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Compare the advantages and disadvantages between classification systems. 2. Assess the application needs of a particular classification system. 3. Select the appropriate parameters for the application of the classification system. 4. Apply the classification system to a specific example.		

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Pernar, N., 2017: Tlo; nastanak, značajke, gospodarenje. Šumarski fakultet Sveučilišta u Zagrebu, 799 p.
4.2. Additional literature	Krasilnikov, P, J.-J. Ibanez Marti, R. Arnold & S. Shoba, 2016: A Handbook of Soil Terminology, Correlation and Classification. Routledge, London, 448 p.
	FAO, 2015: World reference base for soil resources 2014 International soil classification system for naming soils and creating legends for soil maps. Update 2015, Rome, 203 p.
	USDA & NRCS: Soil Taxonomy. A Basic System of Soil Classification for Making and Interpreting Soil Surveys. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051232.pdf

1. GENERAL DATA			
1.1. Name of the course	COLLOIDAL COMPLEX AND SOIL CHEMISTRY	1.6. Course teacher(s)	Prof. Nikola Pernar, PhD Prof. Darko Bakšić, PhD
1.2. Name of the module (if applicable)	FOREST SOILS	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/nikola-pernar/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/darko-baksic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	8 + 10 + 8
1.4. No. of the course	12	1.9. ECTS credits	7
1.5. Code of the course	DSU14	1.10. Language(s)	Croatian ☒ English ☒

2. COURSE DESCRIPTION	
2.1. Course objectives	The aim of the course is to provide students with knowledge of the part of soil physics and chemistry that plays a key role in understanding the nutritional status of soil and its protective and buffering function in nature. Furthermore, the aim is to enable the upgrading of knowledge in colloid chemistry and its application in pedogenesis and pedophysiography.
2.2. Course contents (syllabus)	The nature of soil colloids. Types of soil sorption. Sorption models. Cation sorption. Anion sorption. Soil sorption capacity. Soil sorption characteristics and soil acidity. Sorption characteristics and soil fertility.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Explain the principles of soil sorption. 2. Explain the composition and role of the colloidal soil complex. 3. Analyze sorption characteristics of soil on specific soil samples. 4. Present the role of the colloidal complex in the nutritional status of the soil.

3. MONITORING AND EVALUATION OF STUDENT WORK						
	Class attendance	☐	Research	☐	Oral exam	☒

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Pernar, N., 2017: Tlo; nastanak, značajke, gospodarenje. Šumarski fakultet Sveučilišta u Zagrebu, 799 p.					
4.2. Additional literature	Sumner, E. M., 2000: Handbook of Soil Science. CRC Press, London – New York – Washington.					
	Scheffer, F. & P. Schachtschabel, 2010: Lehrbuch der Bodenkunde 16. Auflage neu bearbeitet von: Blume, H. P., G. W. Brummer, R. Horn, E. Kandeler, I. Kogel-Knabner, R. Kretzschmar, K. Stahr & B. M. Wilke. Spektrum Akademische Verlag Heidelberg, Berlin, 578 p.					

1. GENERAL DATA			
1.3. Name of the course	NEW KNOWLEDGE ABOUT WILDLIFE BREEDING IN NATURE	1.6. Course teacher(s)	Prof. Marijan Grubešić, PhD Assist. Prof. Kristijan Tomljanović, PhD
1.4. Name of the module (if applicable)	Hunting management	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/marijan-grubesic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/kristijan-tomljanovic/
1.6. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	10+12+10
1.7. No. of the course	13	1.9. ECTS credits	7
1.8. Code of the course	DSU18	1.10. Language(s)	Croatian ☐ English ☒
2. COURSE DESCRIPTION			
2.4. Course objectives	The aim of the course is to acquaint students with new technical and technological achievements that are applied in the breeding and protection of wildlife in natural conditions. New technologies and their results are very often the topic of some international scientific and professional conferences.		
2.5. Course contents (syllabus)	New knowledge on the breeding of certain economic species of game, such as deer, fallow deer, roe deer, mouflon, chamois, wild boar, bear, rabbit, reed, pheasant, wetland bird and other interesting hunting species will be processed. The most appropriate breeding and protection measures depending on the species of game and habitat conditions will be considered. The candidate acquires knowledge in the field of technology of breeding and protection of game in open hunting grounds, ie in nature. With new knowledge, he expands his own creativity and with his work introduces a new approach to better hunting management. Teaching is designed to a greater extent on independent work, both through the collection of new works and through a tour of hunting grounds in Croatia and abroad. The student is involved in team work and through analysis and critical discussion of individual segments of the proposed technology related to game breeding and protection, the individual and the group (team) make decisions about the pros and cons of each technological process. The student must independently look for papers that will address a particular topic from the breeding and protection of certain species of game, and then be a moderator of the discussion on the proposal. It is obligatory to stay in hunting grounds of more intensive management through exercises and field classes (which should not be individually limited). It is planned to host foreign		

	experts who would expand the knowledge of applicants from the above issues through lectures and presentations of their experiences.					
2.6. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Introduction to modern achievements of game breeding in open hunting grounds 2. Introduction to modern techniques and technology used in hunting management 3. Organization of professional work, scientific research work in the field of hunting 4. Analysis and data processing, writing professional reports and studies					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☒		
4. LITERATURE LIST						
4.1. Obligatory literature	Andrašić, D., 1984: Zoologija divljači i lovna tehnologija. Skripta, Sveučilište u Zagrebu Šumarski fakultet, Zagreb, 294 s.					
	Čeveny, J., P. Hell, J. Slamečka, 2004: Enciklopedia Plovnictva. Ottovo nakladatelstvo, Praha, 591 s.					
	Grupa autora, 1967: Lovački priručnik. Lovačka knjiga, Zagreb, 704 s.					
	Grupa autora, 1987: Velika ilustrovana enciklopedija lovstva 2. Građevinska knjiga, Beograd, 488 s.					
	Mustapić, Z., i sur., 2004: Lovstvo. Priručnik, Hrvatski lovački savez, Zagreb, 597 s.					
	Grupa autora, 1987: Velika ilustrovana enciklopedija lovstva 2. Građevinska knjiga, Beograd, 488 s.					
4.2. Additional literature	Matić, S. (ur.), 2011: Šume hrvatskog Sredozemlja. Akademija šumarskih znanosti, Zagreb, 748 s.					
	Silvy, N. J., 2012: The wildlife techniques manual research. 7th edition, the John Hopkins university press, Baltimore, 414 s.					
	Rauš, Đ. (ur.), 1992: Šume u Hrvatskoj. Šumarski fakultet Sveučilišta u Zagrebu i Hrvatske šume, Zagreb, 348 s.					

1. GENERAL DATA			
1.1. Name of the course	Habitat valorization in game breeding	1.6. Course teacher(s)	Prof. Marijan Grubešić, PhD Assist. Prof. Kristijan Tomljanović, PhD
1.2. Name of the module (if applicable)	Hunting management	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/marijan-grubesic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/kristijan-tomljanovic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	10+10+6
1.4. No. of the course	14	1.9. ECTS credits	7
1.5. Code of the course	DSU18	1.10. Language(s)	Croatian ☐ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to acquaint students with the procedures and methodology of habitat valorization as an important element of planning in hunting and protection of animal species.		
2.2. Course contents (syllabus)	Getting to know the basic factors in the habitat (natural and anthropogenic factors), their importance for individual species, the interdependence of individual factors and the interaction on wildlife. Assessment of the overall effect of habitat factors on individual animal species. Habitat quality assessment, determination of optimal habitat load. Intraspecific and interspecific competition, competition, substitution. Simulation of the dominance of individual factors and reflection on populations of animal species. Determining the optimal relationships (capacities) in the food pyramid in a particular ecosystem (lowland, hilly, mountainous and coastal areas), the relationship between habitat and incoming species, harmonization of mutual relations in the associated food pyramid. Reflection of the relationship in the food pyramid on planning in hunting management and interventions in a particular population. Permanent preservation of natural balance. Interventions in disturbed population relations. Teaching includes the presentation of new techniques and technologies in habitat analysis, related to field work and direct acquaintance with habitat opportunities. The acquired knowledge in the field of remote sensing is also used in teaching. With specific tasks and examples, each student practically carries out the valorization of a certain area for the corresponding game species.		
2.3. Expected learning outcomes at the level of	1. Introduction to the methodology of habitat valorization in game breeding in open hunting grounds		

the course (4 to 7 learning outcomes)	2. Introduction to software and techniques used in habitat analysis 3. Organization of professional work, scientific research work in the field of hunting 4. Analysis and data processing, writing professional reports and studies					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☒		
4. LITERATURE LIST						
4.1. Obligatory literature	Andrašić, D., 1984: Zoologija divljači i lovna tehnologija. Skripta, Sveučilište u Zagrebu Šumarski fakultet, Zagreb, 294 s.					
	Andričević, R., H. Gotovac, I. Ljubenkov, 2007: Geostatistika: umijeće prostorne analize. Sveučilište u Splitu, udžbenik, 170 s.					
	Grupa autora, 1967: Lovački priručnik. Lovačka knjiga, Zagreb, 704 s.					
	Lang, S., T. Blaschke, 2010: Analiza krajolika pomoću GIS-a. ITD Gaudeamus, Požega. Naslov izvornika: Landschaftanalyse mit GIS, 2007, Eugen Ulmer KG, Stuttgart, Germany, 375 s.					
	Mustapić, Z., i sur., 2004: Lovstvo. Priručnik, Hrvatski lovački savez, Zagreb, 597 s.					
4.2. Additional literature	Matić, S. (ur.), 2011: Šume hrvatskog Sredozemlja. Akademija šumarskih znanosti, Zagreb, 748 s.					
	Silvy, N. J., 2012: The wildlife techniques manual research. 7th edition, the John Hopkins university press, Baltimore, 414 s.					
	Rauš, Đ. (ur.), 1992: Šume u Hrvatskoj. Šumarski fakultet Sveučilišta u Zagrebu i Hrvatske šume, Zagreb, 348 s.					
	Vukelić, J. (ur.), 2005: Poplavne šume u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 460 s.					

1. GENERAL DATA			
1.3. Name of the course	Woody Plants in Landscape Design	1.6. Course teacher(s)	Prof. Marilena Idžojtić, PhD Assist. Prof. Igor Poljak, PhD
1.4. Name of the module (if applicable)	Urban Forestry	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/marilena-idzojtic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/igor-poljak/
1.6. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	7 + 10 + 7
1.7. No. of the course	15	1.9. ECTS credits	7
1.8. Code of the course	DSZ2	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.4. Course objectives	Students acquire knowledge about the selection and use of woody ornamental plants for landscaping green areas based on various criteria. The goal is to achieve an aesthetically pleasing and functional space by properly selecting and arranging woody ornamental plants, which form the basis of most gardens and parks. Students will learn which criteria should be taken into account when choosing woody plants, according to the specifics and characteristics of green areas, but also according to the requirements of users or projects. They also acquire the skill of choosing individual woody ornamental plants based on these criteria.		
2.5. Course contents (syllabus)	Assuming that students have prior knowledge of dendrology and horticultural dendrology within this course will learn what are the criteria for proper selection of woody ornamental plants for landscaping and how to narrow the selection of possible species based on these criteria. In order to select the appropriate ornamental woody plants for an area, a number of different factors need to be considered. It is necessary to know the species and cultivars, their biological properties, morphological characteristics, ecological requirements and range. According to the characteristics of the area and the request of the user or project, students will learn to offer appropriate solutions. Criteria for selection of ornamental woody plants are: 1. habit, 2. durability of leaves, 3. shape, size and color of leaves, 4. shape, size, color and scent of flowers, 5. shape, size, color, scent and consistency of fruits, 6. color and texture of bark, color and thickness of shoots in winter, 7. growth rate, 8. origin of plants, 9. specificity in a particular season, 10. edibleness or aromaticity of individual plant parts, 11. negative effects, 12. ecological requirements.		

2.6. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Determine the combination of criteria to be considered for the selection of woody ornamental plants for landscaping according to the characteristics of the area. 2. Determine the combination of criteria to be taken into account for the selection of woody ornamental plants for landscaping according to the requirements of the user or project. 3. Select and recommend ornamental woody plants based on these criteria. 4. Present the appearance of selected woody ornamental plants in different seasons. 5. Present the possible positive and negative effects of ornamental woody plants.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☒		
4. LITERATURE LIST						
4.1. Obligatory literature	Idžojtić, M., 2005: Listopadno drveće i grmlje u zimskom razdoblju. Šumarski fakultet Sveučilišta u Zagrebu. 256 pp.					
	Idžojtić, M., 2009: Dendrologija – List. Šumarski fakultet Sveučilišta u Zagrebu. 904 pp.					
	Idžojtić, M., 2013: Dendrologija – Cvijet, češer, plod, sjeme. Šumarski fakultet Sveučilišta u Zagrebu. 672 pp.					
4.2. Additional literature	Bärtles, A., P. A. Schmidt, 2014: Enzyklopädie der Gartengehölze. Verlag Eugen Ulmer, Stuttgart, 888 pp.					
	Church, G., 2002: Trees and shrubs for foliage. Firefly Books, Willowdale. 159 pp.					
	Dirr, M. A., 2011: Dirr's encyclopedia of trees and shrubs. Timber Press. 952 pp.					
	Gelderen, D. M. van, P. C. de Jong & H. J. Oterdoom, 1994: Maples of the world. Timber Press, Portland, Oregon. 458 pp.					
	Gelderen, D. M. van & J. R. P. van Hoey Smith, 1996: Conifers: The illustrated encyclopedia. Timber Press.					
	Idžojtić, 2019: Dendrology: Cones, Flowers, Fruits and Seeds. Elsevier – Academic Press, London, San Diego, Cambridge,					
	Stoeklein, M. C., 2011: The complete plant selection guide for landscape design. Purdue University Press. 750 pp.					
	Vertrees, J. D., 2001: Japanese maples. Timber Press, Portland. 332 pp.					

1. GENERAL DATA			
1.3. Name of the course	Methods and models for determining the value of forests	1.6. Course teacher(s)	Prof. Stjepan Posavec, PhD
1.4. Name of the module (if applicable)	Urban Forestry	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/stjepan-posavec/
1.6. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6+4+14
1.7. No. of the course	16	1.9. ECTS credits	7
1.8. Code of the course	DSZ23	1.10. Language(s)	Croatian ☒ English ☐

2. COURSE DESCRIPTION	
2.4. Course objectives	Introduction to classical and modern methods of determining the value of forests, methods of calculation and differences. Estimation of the value of a stand or forest management unit. Calculation of the fee for an individual stand. Writing a seminar paper with the analysis of examples of forest value assessment from domestic and foreign literature.
2.5. Course contents (syllabus)	A description of the different ways in which natural resource economists are used to calculate the price of natural resources or natural processes that have social value. The concept and importance of determining the value of forests as renewable natural capital. Achievements and works in this field so far. The scientific approach should address the value of forests by optimizing the interaction of different factors in the concept of determining the total value of forests by including in addition to economic and other factors, the so-called non-utilitarian. An overview of forest valuation methods. The role of value of products and services in forestry and wood processing in the concept of bioeconomy.
2.6. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Valorize methods of estimating the value of ecosystem services 2. Assess the specifics of determining the value of forests 3. Compare economic policy instruments that affect valuation. 4. To determine the importance and role of forestry and wood processing industry in the development of bioeconomy.

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the	Class attendance	☒	Research	☒	Oral exam	☐
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐

evaluation of achieved learning outcomes	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Figurić, M.: UVOD U EKONOMIKU ŠUMSKIH RESURSA, Šumarski fakultet, Zagreb, 1998					
	SABADI, R.: VREDNOVANJE ŠUMA U NJIHOVOJ UKUPNOSTI, Hrvatske šume, Zagreb, 1997					
	Posavec, S.; Kajba, D.; Beljan, K.; Boric, D.: Economic analysis of short rotation coppice investment: Croatian case study, AUSTRIAN JOURNAL OF FOREST SCIENCE, 2017, volume 134, 163-176					
	Kajanus, M.; Leban, V.; Glavonjic, P.; Krc, J.; Nedeljkovic, J.; Nonic, D.; Nybakk, E.; Posavec, S.; Riedl, M.; Teder, M.; Malovrh, Špela Pezdevsek; Paletto, Alessandro; Posavec, Stjepan; Dobsinska, Zuzana; Dordevic, Ilija; Maric, Bruno; Avdibegovic, Mersudin; Kitchoukov, Emil; Stijovic, Aleksandar; Trajkov, Pande; Laktic, Tomislav. Evaluation of the Operational Environment Factors of Nature Conservation Policy Implementation: Cases of Selected EU and Non-EU Countries, FORESTS, 2019, volume 10, issue 12					
	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 HAZU, 516-523 str., Zagreb					
4.2. Additional literature	KLEMPERER, W.D.: FOREST RESOURCE ECONOMICS AND FINANCE, McGraw-Hill Book Comp., New York, 1996					

1. GENERAL DATA			
1.3. Name of the course	Integrated management of protected areas	1.6. Course teacher(s)	Full professor Ivan Martinić, PhD
1.4. Name of the module (if applicable)	Nature protection	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/
1.6. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6+8+10
1.7. No. of the course	17	1.9. ECTS credits	7
1.8. Code of the course	DSZ6	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.4. Course objectives	Develop the doctoral student's ability to independently plan and perform various tasks in the functioning of the protected areas (Pas): understanding of global policies / programs and international management standards and their integration into the management of the the PAs; program and financial management of the PA insitution's departments; Strengthen competencies of doctoral student for team and project approach in the PAs management: analysis, preparation and implementation of programs and documents, design of management measures, organization of monitoring system, visitor system management, programming of operational supervision, management of department's units, development of cooperation with environment (scientific and professional institutions, business entities, local and regional authorities) and with various interest groups related to the functions of the PAs, etc.		
2.5. Course contents (syllabus)	(I.) Evaluation of PAs. GIS and databases in the evaluation of the PAs. Valuation of goods and services of the PAs - C/B analysis. Planning of the PAs - special international planning criteria (IUCN, UNESCO); (II.) Global policy of the PAs - IUCN matrix of objectives in the PAs management. International management standards of the PAs - adaptive management, participation and sustainability; (III.) Management plans for the PAs. Analytical and project phase in the preparation of the Management plan. International and Croatian guidelines for the development the PAs management plans. The role and activities of the management institution. Monitoring and evaluation of the effectiveness of protected area management. Financing of the PAs; (IV.) Tourist function of the PAs. Visitor risk management in the PAs. Visitor management - measures to regulate visits. Models for defining the reception capacity of visits (LAC method); (V.) The PAs management and environmental relations. Participatory processes - stakeholder forum, stakeholder steering committee. Cooperation with regional and local communities - framework, approaches and areas of cooperation.		
2.6. Expected learning outcomes at the level of	(1) understand models of bio-ecological, spatial and economic evaluation of natural areas and models of planning and principles of spatial planning in the PAs; (2) master the policies of the PAs management through the adoption of international		

the course (4 to 7 learning outcomes)	standards for the concept of individual segments of management - adaptive management, participation, sustainability; (3) competently program management documents (Management Plan, Spatial Plan, Annual Work Program) and financing of the PAs; (4) apply international criteria and guidelines in the development of the tourism function in the PA (types and intensity of tourism, financial effects and risks, tourism management, visitor systems, reception capacity of the PAs); (5) to position the management of the PA in relation to the relevant social environment and stakeholders.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☒	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☒	Practical work	☐	Click or tap here to enter text.	☐
	Project	☒	Written exam	☒		
4. LITERATURE LIST						
4.1. Obligatory literature	Martinić, I.: Upravljanje zaštićenim područjima prirode – planiranje, razvoj i održivost, Zagreb 2010.					
	Smjernice za planiranje upravljanja zaštićenim područjima i/ili područjima ekološke mreže, MZOE/HAOP, Zagreb 2020					
	Zakon o zaštiti prirode (integralni pročišćeni tekst)					
	Middleton, J., T. Lee: Guidelines for Management Planning of Protected Areas, IUCN WCPA, 2008					
	Müller, H., Turizam i ekologija. Povezanost i područja djelovanja. Masmedia, Zagreb, 2004					
4.2. Additional literature	Tourism and visitor management in protected areas, IUCN WCPA, 2018					
	Martinić, I.: Priručnik za edukatore i vodiče u prirodi, Fakultet šumarstva i drvne tehnologije, Zagreb, 2021.					
	Strategija i akcijski plan zaštite prirode Republike Hrvatske za razdoblje od 2017. do 2025. godine, NN 72/17					
	Zbornik radova “Vizija i izazovi upravljanja zaštićenim područjima prirode u Republici Hrvatskoj - Aktivna zaštita i održivupravljanje u Nacionalnom parku “Krka” / Marguš, D. (ur.)., JU "Nacionalni park Krka", 2017.					

1. GENERAL DATA

1.1. Name of the course	Conservation and protection of biological and landscape diversity	1.6. Course teacher(s)	Prof. Željko Španjol, Ph.D. Prof. Damir Barčić, Ph.D.
1.2. Name of the module (if applicable)	Nature protection	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/zeljko-spanjol/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/damir-barcic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6+4+14
1.4. No. of the course	18	1.9. ECTS credits	7
1.5. Code of the course	DSZ22	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	Develop basic knowledge of methods of protection and conservation of biological diversity. Knowledge of protected areas, establishment of management models. Explain the structure and organization of nature protection with the aim of sustainability.		
2.2. Course contents (syllabus)	The introductory part is followed by topics related to factors that affect nature, the organization of nature protection in our country and in the world, the most important laws, documents and conventions in the field of nature protection. Particular attention is paid to the categories of protected areas and management models of species and habitats.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Interpret the analysis and interpretation of biological and landscape diversity and the classification of protected forest areas. 2. Present management plans in protected areas, structure, division, structure, features and evaluation of national parks and nature parks. 3. Analyze the protection of flora and fauna, endangerment of plant species and habitats, categorization of endangerment 4. Analyze and interpret habitat values in accordance with the National Classification and the Natura 2000 ecological network		

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	**Click or tap here to enter text.**	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Španjol, Ž., Barčić, D., 2020: Zaštita prirode (interna skripta), Fakultet šumarstva i drvne tehnologije, Zagreb.
	Pregled stanja biološke i krajobrazne raznolikosti Hrvatske sa strategijiom i akcijskim planovima zaštite. Državna uprava za
4.2. Additional literature	Biološka raznolikost - priručnici za inventarizaciju i praćenje stanja, 2006: Državni zavod za zaštitu prirode. Zagreb.

1. GENERAL DATA			
1.1. Name of the course	Models of multi-objective and sustainable even-aged and uneven-aged forest management planning	1.6. Course teacher(s)	Prof. Jura Čavlović, PhD Assoc. Prof. Krunoslav Teslak, PhD
1.2. Name of the module (if applicable)	Forest management planning	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/jura-cavlovic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6 + 12 + 6
1.4. No. of the course	19	1.9. ECTS credits	7
1.5. Code of the course	DSZ8	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) to provide review for knowledge renewing and acquisition about basic issues of even-aged and uneven-aged forest regulation, control and management planning, 2) to enable and train students for consideration of spatial-temporal dynamics of forest influenced with management systems and internal and external factors, 3) to enable and guide students for study and research of specific problems in even-aged and uneven-aged forest management.		
2.2. Course contents (syllabus)	In the framework of this subject the basic components of even-aged forest management planning are contained. With preliminary repetition and tracing knowledge of basic foundations of even-aged and uneven-aged forest management planning: normal model of regulated even-aged and uneven-aged forest, prescribed thinning and felling cut and selection cut, methods of control and regulations of even-aged and uneven-aged forests, hypothetical models of uneven-aged forests, recruitment, increment, spatial forest regulation), the special part of the subject relates to study and research elements of even-aged and uneven-aged forest management planning and its interrelationships in actual examples: planning of cut in even-aged and uneven-aged forests with unstable and irregular stand structure and age class structure, modeling and projection of age class distribution in even-aged forests; modeling and projection of diameter-class distribution in uneven-aged forests; rotation and cutting age of stand as elements of even-aged forest management planning; maturity cut as		

	element of uneven-aged forest management planning; determination of site and stand quality in even-aged forests; determination of management classes, aims and goals in forest management. Moreover, in the framework of presented range of topics under even-aged forest management planning system, agreeing of student preference, chose of specific topics for study and research, as well as object of research (actual problem, tree species, etc.) can be in the content of topic of doctor thesis.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) Describe and explain elements of defining balanced forest structure in even-aged forest management, 2) Describe and explain elements of defining balanced forest structure in uneven-aged forest management, 3) To use of existing stand/forest growth simulators, 4) To project alternative scenarios of forest develpment and management, 5) Evaluate of different approaches (models) of forest management, 6) Discuss critically specific issues of forest management planning reviewed and studied in scientific articles.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Bettinger, P., Boston, K., Siry, J.P. & D.L. Grebner, 2009: Forest Management and Planning. Academic Press is an imprint of Elsevier, Burlington i London, 331 str.
	Čavlović, J., 2013: Osnove uređivanja šuma. Sveučilište u Zagrebu, Šumarski fakultet, 322 pp.
	Davis, L.S., Johnson, K.N., Bettinger, P.S. & T.E. Howard, 2001: Forest Management: To Sustain Ecological, Economic, and Social Values, 4th ed.; McGraw-Hill Book Company: New York, NY, USA, 2001.

	Klepac, D., 1965: Uređivanje šuma, Nakladni zavod Znanje, Zagreb, 341 pp.
	Knuchel, H., 1953: Planning and Control in the Managed Forest, Edinburgh, 360 str.
	Čavlović, J., Kremer, D., Božić, M., Teslak, K., Vedriš, M., Goršić, E., 2010: Stand growth models for more intensive management of Juglans nigra: A case study in Croatia. Scandinavian Journal of Forest Research, 25(2): 138-147
4.2. Additional literature	Teslak, K., Čavlović, J., Božić, M., 2012: The even-aged forest development computer program SIMPLAG: design, structure and application. Šumarski list, 136(7-8): 331-342
	Čavlović, J., Antonić, O., Božić, M., Teslak, K., 2012: Long-term and country scale projection of even-aged forest management: a case study for Fagus sylvatica in Croatia. Scandinavian Journal of Forest Research, 27 (1): 36-45.
	Čavlović, J., Božić, M., Bončina, A., 2006: Stand structure of an uneven-aged fir-beech forest with an irregular diameter structure: modeling the development of the Belevine forest, Croatia. European Journal of Forest Research 125(4): 325-333
	Bončina, A., Čavlović, J., Curović, M., Govedar, Z., Klopčić, M., Medarević, M., 2014: A comparative analysis of recent changes in Dinaric uneven-aged forests of the NW Balkans. Forestry, 87: 71-84.
	Čavlović, J., Bončina, A., Božić, M., Goršić, E., Simončić, T., Teslak, 2015: Depression and growth recovery of silver fir in uneven-aged Dinaric forests in Croatia from 1901 to 2001, Forestry, 07/2015.
	+ free choosed scientific articles (up to 10 articles)

1. GENERAL DATA			
1.1. Name of the course	Forest trees and stand growth and increment modelling	1.6. Course teacher(s)	prof. dr. sc. Mario Božić, doc. dr. sc. Ernest Goršić
1.2. Name of the module (if applicable)	Forest management	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/mario-bozic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ernest-gorsic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6+12+6
1.4. No. of the course	20	1.9. ECTS credits	7
1.5. Code of the course	DSZ9	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	Determining current and acquiring new knowledge related to tree and stand growth and increment with emphasis on growth and increment modelling. Gaining experience in percieving complexity of relationships between tree and stand growth and factors that influence it. To qualify students for collecting data and creating both simple and complex tree and stand growth models in program package Statistica.		
2.2. Course contents (syllabus)	The subject is focusing on tree and stand growth and increment in function of different factors that influenc it (climate, geomorphology, biotic, athropogenic etc.) which influence growt and increment. Beside indiviadual growth factors, their interaction influencing growth and increment of trees and stands will be observed. Students will be introduced with construction of complex models which can serve as estimates for tree and stand increment. The benefits of such models in relation to "classic" increment determination will be presented. Importance od certain growth factors for growth and increment will be defined separately for certain tree species in even age (pure and mixed) and selection stands.Beside quantitative increment, within the course particular attention will be given to quality of wood increment and its financial		

	effect. Students will be introduced to the problematic of data collection and preparation (dependant and independant variables) which are used for complex modelling. Tree and stand growth simulators will be introduced as well (origin, utilization and usability in paticular situations). Furthermore, in acordance with preferences of particular candidate specific topic wil be selected for studies and research (specific problem, tree species etc.) which can be in function of dissertation topic.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Defining factors that influence growth and increment. 2. Analyze growth and increment of individual trees. 3. Ascertain influence of management procedures and stand changes on tree and stand increment. 4. Explain development dinamics in even age, uneven age and selction stands. 5. Use of Statistica software package. 6. Create both simple and complex tree increment models. 7. Evaluate applicability of certain models in science and practice.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Božić, M., 2003: Utjecaj stanišnih i sastojinskih elemenata na prirast obične jele (Abiesalba Mill.) u jelovim sastojinama na kršu u Hrvatskoj. Disertacija. Šumarski fakultet Sveučilišta u Zagrebu. Zagreb.
	Božić, M., Čavlović, J., Teslak, K., 2006: Modeliranje prirasta jelovih stabala na temelju sastojinskih čimbenika. Glasnik za šumske pokuse, (Posebno izdanje 5): 443-454.
	Peng, C., 2000: Growthandyieldmodels for uneven-agedstands: past, presentand future. ForestEcologyand Management 132, 259-279.

	Bartelink, H.H., 2000: A growth model for mixedforeststands. ForestEcologyand Management 134, 29-43.
4.2. Additional literature	Pretzsch H., 2009:Forest Dynamics, Growth, andYield. Springer, Berlin, Heidelberg.
	Pretzsch, H., 2001: ModellirungdesWaldwachstums. PareyBuchverlag, Berlin.
	Pretzsch, H., 2005: StanddensityandgrowthofNorwayspruce (Piceaabies(L.) Karst.) and European beech (FagussylvaticaL.): evidencefromlong-termexperimentalplots. EuropeanJournalofForest Research 124, 193-205.
	Mäkinen, H., Nöjd, P., Kahle, H-P., Neumann, U., Tveite, B., Mielikäinen, K., Röhle, H., Spiecker, H., 2002: RadialgrowthvariationofNorwayspruce (Piceaabies (L.) Karst.) acrosslatitudinalandaltitudinalgradientsincentralandnorthern Europe. ForestEcologyand Management 171, 243-259.
	Miina, J., Pukkala, T., 2002: Aplicationofecologicalfieldtheoryin distance-dependetgrowthmodelling. ForestEcologyand Management 161,101-107.
	+ selected scientific articles according to the special preferences of each student (maximum 10 articles)

1. GENERAL DATA			
1.1. Name of the course	ASSESSMENT OF FOREST CONDITIONS BY REMOTE SENSING METHODS	1.6. Course teacher(s)	Prof. Renata Pernar, PhD
1.2. Name of the module (if applicable)	REMOTE SENSING AND GIS IN FORESTRY	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/renata-pernar-rodj-fintic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6 + 14 + 4
1.4. No. of the course	21	1.9. ECTS credits	1
1.5. Code of the course	DSZ14	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	To acquaint students with the latest achievements in the field of image interpretation in our country and in the world, with a focus on recognizing vegetation types, tree species and determining the health status of vegetation (individual trees), theoretical foundations, types of recording systems and recording methods, and possibilities of aero and satellite recordings for assessing and monitoring the condition of stands.		
2.2. Course contents (syllabus)	Photographs, types and characteristics. Influence of certain factors on the readability of images (shadows, clouds, scale, image quality, recording time, type of photolayer). Image components important for photointerpretation (color, tone, size, pattern, shape,…). Image analysis procedures (detection, delineation, measurement, differentiation, classification, coding,…). Ways of interpreting recordings. Types and characteristics of photointerpretation keys. Photointerpretive reading of different types of aerial photographs with a focus on recognizing vegetation types, tree species and determining the health status of vegetation (individual trees). Application of CIR aerial photographs to determine vegetation damage. Preparation of measurement images, measurement photointerpretation. Aerial phototaxis. Determination of dendrometric parameters for individual trees and forest stands. Classification of forest terrains. Determination of altitude, inclination and exposure on aerial photographs. Non-photographic recording systems. Application of satellite images for assessment and monitoring of stand condition. Digital interpretation of aerial and satellite images.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Identify image components important for photointerpretation (color, tone, size, pattern, shape,…). 2. Explain image analysis procedures (detection, delineation, measurement, differentiation, classification, coding,…) 3. Interpret different types of recordings 4. Apply different types of photointerpretation keys		

	5. Perform measurement photointerpretation (aerial phototaxis). 6. Assess the health of vegetation (individual trees) 7. Recommend different types of images (aero and / or satellite) to assess and monitor the condition of stands					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☒
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Franklin, S. E. (2001): Remote Sensing for Sustainable Forest Management. Lewis Publishers, USA, 407 str					
	Howard, J., A. (1991): Remote Sensing of Forest Resources: Theory and application, Chapman & Hall, London, 420 str.					
4.2. Additional literature	Najnoviji radovi objavljeni u domaćim i stranim stručnim i znanstvenim časopisima.					
	Oluić, M. (2001): Snimanje i istraživanje Zemlje iz svemira, HAZU, Zagreb, 580 str.					

1. GENERAL DATA			
1.1. Name of the course	APPLICATION OF REMOTE SENSING AND GIS IN MAPPING AND MODELING	1.6. Course teacher(s)	Prof. Renata Pernar, PhD Prof. Ante Seletković, PhD
1.2. Name of the module (if applicable)	REMOTE SENSING AND GIS IN FORESTRY	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/renata-pernar-rodj-fintic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ante-seletkovic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6 + 14 + 4
1.4. No. of the course	22	1.9. ECTS credits	7
1.5. Code of the course	DSZ12	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Students are introduced to the types and models of spatial data, sources and methods of data collection for spatial analysis, making different thematic layers using RS and GIS methods (mapping land use, vegetation, stand damage, biodiversity, game distribution, etc.), and basic procedures and possibilities of application of spatial analyzes and valorization of space in forestry, and urban and protected areas.		
2.2. Course contents (syllabus)	Spatial data collection, primary and secondary methods, data quality. Data processing and analysis. Spatial data exchange. Spatial data modeling. Basic concepts related to creating, editing, handling, searching, analyzing, displaying and plotting maps in GIS. GIS capabilities for performing various analyzes. Development of a digital relief model by photogrammetric methods. Making a mosaic of several digital images, and geocoding the resulting mosaic. Making a digital orthophoto. Implementation of RS products in GIS. Digitization. Thematic mapping. Production of various thematic maps using RS and GIS methods (mapping of land use, vegetation, stand damage, biodiversity, game distribution, etc.). Application of aerial photographs and DRM for the design of forest roads, planning and analysis of works in forest management. Aerial photographs and GIS as a tool for establishing a cadastre of trees in urban areas.		
2.3. Expected learning outcomes at the level of	1. Explain spatial data models (vector, raster) 2. Connect different data sources and ways of collecting them for spatial analysis		

the course (4 to 7 learning outcomes)	3. Design and organize a spatial database 4. Implement merging of raster and vector data in GIS (implementation of RS products in GIS). 5. Create a digital relief model (DRM) and digital orthophoto (DOP) 6. Analyze and valorize the results of different spatial analyzes for forestry needs 7. Propose applications of RS and GIS products in solving various tasks for the needs of planning, management and administration in forestry.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☒
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Skidmore A. (2003): Environmental Modelling with GIS and Remote Sensing. Taylor & Francis, London, 268 str.					
	Maguire, D. J., Batty, M. (ur.) (2005): GIS, Spatial Analysis, and Modeling. ESRI Press, USA. 480 str.					
	Andričević R., H. Gotovac, I. Ljubenkov, (2007): GEOSTATISTIKA: umijeće prostorne analize, Udžbenik					
	Lang, S. & T. Blaschke, (2010): Analiza krajolika pomoću GIS-a					
	Richards, J. A. (2013): Remote Sensing Digital Image Analysis. Springer – Verlag, Berlin Heidelberg, 494 str.					
4.2. Additional literature	Najnoviji radovi objavljeni u domaćim i stranim stručnim i znanstvenim časopisima.					
	Ključanin, S., Poslončec-Petrić, V., Bačić, Ž. (2018): Osnove infrastrukture prostornih podataka, Sarajevo: Dobra knjiga. 166 str.					

1. GENERAL DATA			
1.1. Name of the course	Fluctuations of forest insect populations	1.6. Course teacher(s)	Assist. Prof. Milivoj Franjević, PhD
1.2. Name of the module (if applicable)	Pest zoobiotic factors in forest protection	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/milivoj-franjevic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	24: 6 + 6+ 12
1.4. No. of the course	23	1.9. ECTS credits	7
1.5. Code of the course	DSZ4	1.10. Language(s)	Croatian x English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	1. To acquire general knowledge in the field of population dynamics of important forest defoliators and xylophages and the functioning of this group of forest pests and their role in the forest ecosystem. In doing so, they use the analysis of original scientific papers from this domain, adopt the scientific way of critical thinking and the construction of scientific thought. 2. To enable the course participants with problems at the general level of insight into the current level of scientific knowledge and applied application in practice 3. Learn, in case of deeper interest, models and strategies needed to maintain the stability of the forest ecosystem.		
2.2. Course contents (syllabus)	Temporal and spatial changes in forest insect population density (fluctuations and oscillations) have long been of interest to fundamental and applied researchers. The reason for this is the laws behind such dynamic processes, but also the huge consequences that are reflected in the stability of the forest ecosystem. In forestry, the consequences can be multimillion-dollar damages and medium-term disruptions to the normal management of forest resources. The course material includes the mechanisms and laws known to date that govern these processes, the circumstances that affect them (population theories and hypotheses) and the mechanisms for restoring equilibrium. Matter is exposed through the prism of the natural phenomenon "per se" but also through the prism of the consequences that occur in natural forests (under some protection regime) or economic forest areas. Getting acquainted with the principles of changing the temporal and spatial distribution of the most famous forest defoliators and xylophages, the participants also notice the so-called the “weak points” of these systems and the strongholds of modern forest ecosystem management (either economic or protected nature facilities).		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Evaluation of simulations and models of population dynamics of the most important defoliators and xylophages 2. Use of monitoring results to predict changes in temporal and spatial distribution of the most famous forest defoliators and xylophages 3. Evaluation of "weak points" of these systems and strongholds of modern forest ecosystem management 4. Evaluation of consequences arising in natural forests surfaces.		

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	1.Berryman, A.A., 1988: Dynamics of Forest Insect Populations – Patterns Causes, Implications. Plenum Press, New York and London, 603 str.
	2. Speight, M.R., M.D. Hunter & A.D. Watt, 1999: Ecology of Insects – Concepts and Applications Blackwell Science, 350 str.
	3. Speight, R.M. & D. Wainhouse, 1989: Ecology and Management of Forest Insects. Oxford Science Publications, 374 str.
4.2. Additional literature	1. Sauvard, D., 2004: General biology of bark beetles. In: Bark and Wood Boring Insects in Living Trees in Europe, a Synthesis (Lieutier F., Day K.R., Battisti A., Gregoire Jean-Claude, Evans H., editors), Kluwer Academic Publishers, 63-88.
	2. Day, K.R., G. Nordlander, M. Kenis, G. Halldorson, 2004: General biology and life cycles of bark weevils. In: Bark and Wood Boring Insects Boring Insects in Living Trees in Europe, a Synthesis (Lieutier F., Day K.R., Battisti A., Gregoire Jean-Claude, Evans H., editors) Kluwer Academic Publishers, 331-350.
	3. Evans, H.F., L.G. Moraal, J.A. Pajares, 2004: Biology, ecology and economic importance of Buprestidae and Cerymbycidae In: Bark and Wood Boring Insects in Living Trees in Europe, a Synthesis (Lieutier F., Day K.R., Battisti A., Gregoire Jean-Claude Evans H., editors), Kluwer Academic Publishers, 447-476.

1. GENERAL DATA			
1.1. Name of the course	Small rodents population dynamics	1.6. Course teacher(s)	Prof. Josip Margaletić, PhD
1.2. Name of the module (if applicable)	Pest zoobiotic factors in forest protection	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/department-of-forestry/institute-of-forest-protection-and-wildlife-management/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	5 + 5 + 20
1.4. No. of the course	24	1.9. ECTS credits	7
1.5. Code of the course	DSZ3	1.10. Language(s)	Croatian ☐ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Getting acquainted with the latest knowledge on the dynamics and number of populations of individual species of small rodents, calculating their absolute and relative values as a starting point for timely protection measures, rodent ethology, and theoretical and practical foundations of sampling methodology. Introduction to the methods of establishing a database for regular monitoring of the population of these mammals as a cause of damage to trees, as aids for data storage, processing and analysis, and their connection with other disciplines in order to predict epidemics of certain zoonoses for which small rodents reservoirs (hemorrhagic fever with renal syndrome, leptopsyrosis, lyme borreliosis).		
2.2. Course contents (syllabus)	Rodentia class systematics. Type determination. Ecology of small rodents. Abundance (absolute, relative) and population dynamics of small rodents (IT programs). Intra-species and inter-species population relations. Stand elements and habitat influence on individual species of small rodents. Physiology of small rodents. Sensory organs. Methodology of field sampling of small rodents. Laboratory analyzes of sampled animals. Small rodents as causes of tree damage. Perennial monitoring of marked individuals. Age and sex analysis of sampled animals. Investigation of seasonal variability of plant vegetation as a cause of significant differences in food selection. Introduction to the recession phase in population dynamics as a consequence of the influence of climate, diet, parasitism, and intraspecific and interspecific competition.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Enumerate and describe the characteristics of the population of dominant species of small rodents. 2. Describe the spatial distribution of dominant species of small rodents. 3. Identify different methods for determining the density of animal populations. 4. Select and link different methods for determining the density of animal populations depending on the target animal species and the accessibility of its habitat. 5. Enumerate and classify the types between the relationships of animal populations.		

	6. Identify elements of population dynamics of individual species as a consequence of the influence of biotic and abiotic factors. 7. Design, plan and recommend measures to control the abundance of animal species in commercial forests.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Zabel, C.J., Anthony, R.G., 2003: Mammal Community Dynamics. Cambridge university press, 709 str.					
	Manning, A., Dawkins, M.S., 1998: Animal behaviour. Cambridge university press, 450 str.					
	Lacey, E.A., Patton, J.L., Cameron, G.N., 2000: Life unredground the biology of subterranean rodents. The University of Chicago Press, 449 str.					
	Alibhai, S.K., Gipps, J.H.W., 1985: The population dinamics of bank voles. Symposia of the zoological Society of London, 55: 277-313.					
	American Society of Mammalogists, Animal Care and Use Committee. 1998. Guidelines for the capture, handling, and care of mammals as approved by the American Society of Mammalogists. Available at http://asm.wku.edu/commitees/.					
	Ausden, M., 2007: Habitat Management for Conservation. Oxford Univerity Press Inc., New York, 411 pp.					
4.2. Additional literature	Delany, M.J., 1974: The ecology of small mammals. Studies in biology, 51 Edward Arnold, London, 60 str.					
	Flowerdew, J.R. & Gardner, G., 1978: Small rodent populations and food supply in a Derbshire ashwood. J. Anim. Ecol., 47: 725-740.					
	Margaletic, J., Glavas, M., Bäumler, W., 2002: The development of mice and voles in an oak forest with a surplus acorns. Anzeiger für Schädlingskunde / Journal of Pest Science, 75(4): 95–98.					
	Crawley, M.J., 1992: Seed-predators and plant population dynamics. In: Fenner, M., (Ed.), Seeds: The Ecology of Regeneration in Plant Communities. CAB International, str. 157-191.					

	Golley, F.B., Petrusewicz, K., Ryszkowski, L., 2009: Small mammals their productivity and population dynamics. Cambridge University Press, London-New York-Melbourne, 451 pp.
	Kirk, R.E., 1995: Experimental design: Procedures for the behavioral sciences. Brooks/Cole Publishing Company, 921 str.
	Krebs, C.J., 2009: Ecology: The Experimental Analysis of Distribution and Abundance. Pearson, 655 pp.
	Tilman, D., Kareiva, P., 1997: The role of space in population dynamics and interspecific interacions. Princeton University Press, New Jersey, 368 pp.

1. GENERAL DATA			
1.1. Name of the course	Tree bark fungal diseases	1.6. Course teacher(s)	prof. Danko Diminić, PhD
1.2. Name of the module (if applicable)	Tree Pathology and Selection for Resistance	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/department-of-forestry/institute-of-forest-protection-and-wildlife-management/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	7 + 14 + 7
1.4. No. of the course	25	1.9. ECTS credits	7
1.5. Code of the course	DSZ5	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Through the course Fungal diseases of tree bark, doctoral students get acquainted in detail with the causes of diseases of the bark of shoots, branches and trunks, the symptoms they cause, and damage to trees in forest and urban ecosystems. The aim of this course is to acquaint students with the importance of maintaining and possibly improving the health of forest and urban trees, important not only for the individual but also for the ecosystem as a whole in terms of knowledge of a specific group of bark pathogens.		
2.2. Course contents (syllabus)	Fungal organisms occupy the most important place among phytopathogenic organisms of forest and urban trees, therefore the symptoms of disease, physiology and biology and systematics of phytopathogenic fungi of tree bark, pathogenesis and possible preventive and curative protection measures in specific ecological conditions of forest ecosystems and urban areas are discussed in detail. Through lectures, students gain knowledge about this specific group of phytopathogenic fungi, as well as how they adversely affect their host. Through exercises, they gain knowledge and experience in manipulating these organisms, from collecting samples in the field, laboratory analysis and identification of pathogens, to methods of artificial infection (inoculation) of host plants with phytopathogenic fungi of the bark. Through seminars, they independently gather information and gain detailed knowledge about research into current diseases of the bark of forest and urban trees in the world. The course also analyzes the negative impact of humans and various biotic and abiotic factors on the predisposition of trees and / or the impact on the infection and development of bark diseases.		
2.3. Expected learning outcomes at the level of	1. Explain the role of fungal pathogens of tree bark diseases for infected trees in urban areas and forest ecosystems.		

the course (4 to 7 learning outcomes)	2. Compare fungal diseases with non-infectious or non-parasitic pathogens (abiotic factors, harmful insect species, damage from wildlife, etc.). 3. Analyze the most important and current diseases of tree bark in forest and urban ecosystems. 4. Analyze the causes of diseases of the bark of shoots, branches and trunks of trees according to the symptoms of the disease and virulence. 5. Explain the origin and course of bark disease in different tree species. 6. Analyze and interpret the role of predisposing factors to the onset and development of disease (climate change, abiotic and biotic predisposing factors). 7. Analyze possible preventive and curative measures to protect trees from pathogens of bark diseases.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Glavaš, M., 1999: Fungal diseases of forest trees. University of Zagreb, Faculty of Forestry, 281 p.
	Butin, H., 1995: Tree Diseases and Disorders. Oxford University Press, Oxford, 252 str.
	Diminić, D., 2013-2021: Important and current (new) diseases of tree bark and shrubs (lecture presentations in PDF format).
	Strouts, R.G., T.G. Winter, 1994: Diagnosis of ill-health in trees. HMSO, London, 307 str.
	Diminić, D., Kranjec Orlović, J., M. Milotić, 2020: Causes of ash disease. Scientific book: Ecology, restoration and protection of floodplain forests of Posavina, University of Zagreb, Faculty of Forestry, Zagreb, 189–236.
	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

4.2. Additional literature	Glavaš, M., D. Diminić, 2011: Forest tree diseases. In: Matić, S. (ed.): Forests of the Croatian Mediterranean. Academy of Forestry Sciences, Zagreb, 533-555.
	Diminić, D., 2005: Mycoses of poplar and willow bark and leaves. In: Vukelić, J. (ed.) 2005: Floodplain forests in Croatia. Academy of Forestry Sciences, Zagreb, 390–397.
	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.
	Diminic, D; N. Potočić, I. Seletković, 2012: The role of habitat in the predisposition of black pine (Pinus nigra Arnold) on the infection with the phytopathogenic fungus Sphaeropsis sapinea (Fr.) Dyko et Sutton in Istria. Forestry Journal, 136 (1-2): 19–
	Kovač, M., D. Diminić., S. Orlović, M. Zlatković, 2021: Botryosphaeria dothidea and Neofusicoccum yunnanense Causing Canker and Die-Back of Sequoiadendron giganteum in Croatia. Forests 12 (6): 695

1. GENERAL DATA			
1.1. Name of the course	Forest Trees Genetic Resources Conservation	1.6. Course teacher(s)	Assist. Prof. Ida Katičić Bogdan, PhD Prof. Saša Bogdan, PhD
1.2. Name of the module (if applicable)	Tree Pathology and Selection for Resistance	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/sasa-bogdan/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ida-katicic-bogdan/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	5 + 14 + 5
1.4. No. of the course	26	1.9. ECTS credits	7
1.5. Code of the course	DSZ10	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) To teach students the theory of conservation of genetic diversity of forest trees; 2) To train students to design and implement programs for the conservation of genetic diversity of forest trees; 3) To train students to interpret the importance of genetic diversity of forest trees in forest management.		
2.2. Course contents (syllabus)	Depending on their prior knowledge and needs, students can acquire basic knowledge in the field of conservation genetics of forest trees: Concepts of biological and genetic diversity. Methods for determining genetic diversity using genetic tests. Methods for determining genetic diversity using genetic markers. Factors shaping genetic diversity. Geographical variability of forest trees (provenances, races, ecotypes, ecoclines). Spatial genetic variability at the population (stand) level. Temporal changes in the genetic diversity of forest trees. Effective population size, population sustainability analysis, minimum viable population. Biodiversity legislation. In situ methods of genetic diversity conservation. Methods of ex situ conservation of genetic diversity. Management of genetic conservation units (seed stands, clone archives, genetic banks). However, students can acquire knowledge that belongs to the category of upgrading basic knowledge that accompanies the development of professional and scientific achievements in the field and narrower and specific current issues (eg specific methodology of using DNA markers in conservation of forest tree genetic diversity; genetic testing methodology, etc.)		

2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. To explain and distinguish categories of forest genetic resources. 2. To explain the basic methods and procedures for conservation of genetic diversity of forest trees. 3. To identify key legal acts, regulations and entities within the issue of conservation of genetic diversity of forest trees. 4. To discuss the impacts of different management interventions on the genetic diversity of forest trees. 5. To design practical recommendations for good practice of forest tree management.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	White, T. L., W. T. Adams, D. B. Neale, 2007: Forest Genetics. Wallingford, UK, Cambridge, CAB International. p682.					
	Forest Genetic Resources Conservation and Management: In Managed Natural Forests and Protected Areas (in situ).					
	Young, A., Boshier, D., Boyle, T. 2000. Forest Conservation Genetics: Principles and Practice. CABI. 368 str.					
4.2. Additional literature	Selected scientific articles suitable for the specific needs of the student.					

1. GENERAL DATA			
1.1. Name of the course	Rationalization of Timber Harvesting Work	1.6. Course teacher(s)	Prof. Željko Zečić, PhD Assist. prof. Dinko Vusić, PhD
1.2. Name of the module (if applicable)	TIMBER HARVESTING	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/zeljko-zecic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/dinko-vusic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6 + 6 +12
1.4. No. of the course	27	1.9. ECTS credits	7
1.5. Code of the course	DST2	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Within this course, students will acquire the knowledge necessary for the development of models for calculating the productivity of individual machines in timber harvesting systems. The acquired skills will enable them to plan and implement this analysis and synthesis of the results of time studies with the aim of comparing the benefits of using different machines in timber harvesting systems, ie rationalizing their use.		
2.2. Course contents (syllabus)	In this course, by comparing different models for the expression of productivity, individual timber production systems will be analyzed at the subsystem level, and after the synthesis of different models with regard to the interaction of stand conditions, means and methods of work and visualization of individual production systems, basic production systems simulation with the aim of optimization at different operating factors will be elaborated. Felling and processing: The issue of logging and wood production, ie work operations and work interventions based on time studies will be discussed in individual chapters. Based on the processed data and the results of the work, the standard time of the cutter in several types of cuts will be considered. Forms of work organization will be processed, in separate phases of timber harvesting work and in group work, where part of the work operations of processing wood assortments is transferred to the landing. Labor productivity from the beginnings of organized forestry in Croatia until today will be analyzed. Various influential factors in logging and timber production, standards and relevant laws, regulations and instructions for work will be considered. Through exercises and seminars, models of production organization in timber harvesting for certain technologies		

	are considered, as well as models of impact and cost analysis and thresholds of profitability of the use of certain technologies and methods of work. Primary transport of wood: Skidding and forwarding or moving wood from the stump to the landing is one of the most expensive works in timber harvesting. Therefore, great attention will be paid to the productivity of an individual asset or group of means of workr with regard to the most influential factors. In particular, different forms of work organization will be considered with regard to the diversity and specificity of working conditions and the movement of machines on the road. The area of labor cost calculations deserves special attention within this course and will be discussed in detail through individual thematic units. Various limiting factors (soil bearing capacity, sapling condition, snow height, etc.) are significant for individual areas in terms of work organization during the year. The possibility of applying the relevant legal regulations of Central European countries in terms of soil and stand protection in general, and especially standing trees, will be emphasized. Through exercises and seminars, models for selecting the most suitable means of work, models of impact and cost analysis, and profitability thresholds with regard to production, environmental and other factors will be considered. Long-distance transport: Distance of transport as a limiting factor of wood transport. Influential factors of timber truck transport productivity. Calculations of timber truck transport costs. Time study of truck transport of wood as a basis for rationalization of transport costs. Logistics in timber truck transport.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) analyze models for calculating the productivity of means of work in timber harvesting; 2) synthesize different models with respect to the interaction of influential factors, means and methods of work; 3) rationalize the work of individual means of work; 4) optimize timber harvesting systems.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Sundberg, U., Silversides, C.R., 1988: Operational Efficiency in Forestry – Volume 1: Analysis. Kluwer Academic Publishers – Forest Sciences, Dodrechts/Boston/Lancaster, 1 – 219.
	Silversides, C. R., Sundberg, U., 1989: Operational Efficiency in Forestry, Volume 2: Practice. Forestry sciences. Kluwer Academic Publishers, 1–169.
	COST Action FP-0902, 2012: Good practice guidelines for biomass production studies. CNR IVALSA, Sesto Fiorentino, 1–51.
	FAO, 1992: Cost control in forest harvesting and road construction. FAO Forestry Paper 99. Food and Agriculture Organization of the United Nations, Rome, 1–106.
4.2. Additional literature	+ selected scientific articles (maximum 10 articles)

1. GENERAL DATA			
1.1. Name of the course	Modern timber harvesting technologies	1.6. Course teacher(s)	Prof. Tomislav Poršinsky, PhD Assist. prof. Andreja Đuka, PhD
1.2. Name of the module (if applicable)	TIMBER HARVESTING	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/tomislav-porsinsky/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/andreja-djuka/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	24: 6 + 6 + 12
1.4. No. of the course	28	1.9. ECTS credits	7
1.5. Code of the course	DST5	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) To give students an insight into world trends in the development of timber harvesting techniques and technology, 2) To enable students to compare the features of classical and state-of-the-art timber harvesting technologies, 3) To teach students to evaluate the effectiveness of high-tech timber harvesting technologies.		
2.2. Course contents (syllabus)	An overview of the technologies and technical means used in timber harvesting operations. Legal restrictions and declarations. Comparison of tracked and wheeled vehicle driving system. Basic technical characteristics of forest vehicles for technologies without or with a partial contact with forest soil. Limiting factors of fully mechanised harvesting systems. Harvester - forwarder system. Walking harvester. Feller buncher system - articulated tractor. Harvarder. Bundler. Helicopter. Truck tower yarder with attached boom and / or processor head. Steep terrain harvester system and truck tower yarder with attached boom. A combination of modern harvesting technology and animal power. Limiting factors for the use of state-of-the-art harvesting technology. Comparisons of features of classical and modern harvesting technologies. The effectiveness of modern technologies in natural stands. Effectiveness of modern technologies in plantations and crops.		

2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) Evaluation of classical and modern timber harvesting technologies, 2) Advanced analysis to determine marginal factors of using modern technologies, 3) Evaluation of fully mechanized timber harvesting systems, 4) Proposing new methods and knowledge to evaluate efficiency of modern harvesting systems.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☒	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	MacDonald, A.J., 1999: Harvesting Systems and Equipment in British Columbia. FERIC, Handbook No. HB-12, 1–197.					
	Visser, R., & Stampfer, K., 2015: Expanding ground-based harvesting onto steep terrain: A review. CROJFE 36(2), 321-331.					
	Stampfer, K., 2000: Forstmaschinen und Holzbringung I/II. Universität für Bodenkultur Wien, 1–39.					
	Visser, R., & Obi, O. F. (2021). Automation and Robotics in Forest Harvesting Operations: Identifying Near-Term Opportunities. CROJFE 42(1), 13-24.					
	Poršinsky, T., Moro, M., Đuka, A., 2016: Kutovi i polumjeri prohodnosti skidera s vitlom. Šumarski list 140 (5-6), 259-272.					
4.2. Additional literature	Poršinsky, T., 2002: Productivity factors of Timberjack 1210 at forwarding the main felling roundwood in Croatian lowland forests. Glasnik za šumske pokuse 38: 103–132.					
	Stampfer, K., Gridling, H., Visser, R., 2002: Analyses of Parameters Affecting Helicopter Timber Extraction. International Journal of Forest Engineering 13(2): 61–6					
	Heinimann, H.R., Stampfer, K., Loschek, J., Caminada, L., 2001: Perspectives on Central European Cable Yarding Systems In: Proceedings of the International Mountain Logging and 11th Pacific Northwest Skyline Symposium – A Forest Engineering Odyssey. CD ROM. Schiess and Krogstad (editors). December 10-12, 2001, Seattle, Washington, USA: 268–279.					
	Visser, J.M., Stampfer, K., 1998: Cable Extraction of Harvester-Felled Thinnings: An Austrian Case Study. JFE 9(1): 39–46.					

1. GENERAL DATA			
1.1. Name of the course	Optimization of Forest Road Infrastructure	1.6. Course teacher(s)	Prof. Tibor Pentek, PhD Prof. Karl Stampfer, PhD Assist. Prof. Ivica Papa, PhD
1.2. Name of the module (if applicable)	FOREST ROAD INFRASTRUCTURE	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/tibor-pentek/ https://forschung.boku.ac.at/fis/suchen.person_uebersicht?id_in=254&menue_id_in=101&sprache_in=en https://www.sumfak.unizg.hr/en/about/general-information/staff/ivica-papa/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6 + 6 + 10
1.4. No. of the course	29	1.9. ECTS credits	7
1.5. Code of the course	DST9	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Students are trained to implement a complex procedure of qualitative and quantitative analysis of the existing network of forest road infrastructure at the level of strategic and tactical planning. They also gain competences related to different methods and procedures for improving (developing) the existing network of forest road infrastructure with the aim of its optimization.		
2.2. Course contents (syllabus)	Through the curriculum, the methodological procedure of optimizing the network of primary and secondary forest roads is presented based on six stages of work. At each stage, methods, techniques and technologies of work are explained. Criteria for assessing the optimality of the network of forest roads, strip roads and skid trails are established as well as the models for quality assessment. A functional approach to forest opening is presented along with economic, technical-technological, environmental-ecological, socio-aesthetic and comprehensive optimization of the forest road network. In practical work, through workshops, seminars and project assignments, students are trained to independently solve the problem of making primary and secondary studies of forest opening (as an integral part of Management Basics / Management Program) with the		

	aim of providing high quality forest road planning. In doing so, they use GIS, GPS, specialized computer programs, computer simulations, etc.					
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. To understand and critical analyse of strategic and tactical planning of forest roads 2. Describe and explain the concepts of forest road density and primary and secondary opening of forests of different relief areas 3. Establish an analysis of the existing network of primary forest roads based on defined criteria for assessing optimality 4. Evaluate the optimization of the network of primary forest roads – horizontal and vertical 5. To be able to critically discuss the subject with students and teachers based on read scientific articles					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☒	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Dietz, P., H. Löffler, & W. Knigge, 1984: Walderschließung, Eine Lehbruch für Studium und Praxis unter besonderer Berücksichtigung des Waldwegebaus. Verlag Paul Parey, Hamburg und Berlin, p. 1-196, odabrana poglavlja					
	Pentek, T. 2002: Računalni modeli optimizacije mreže šumskih cesta s obzirom na dominantne utjecajne čimbenike, Disertacija, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, s. 1-271., odabrana poglavlja					
	Pičman, D., 2007: Šumske prometnice (sveučilišni udžbenik), Šumarski fakultet Sveučilišta u Zagrebu, s. 1-460, odabrana poglavlja					
4.2. Additional literature	Pentek, T., Pičman, D., Potočnik, I., Dvorščak, P. & H. Nevečerel, 2005: Analysis of an existing forest road network. Croatian Journal of Forest Engineering 26 (1), Zagreb, Croatia, str. 39-50.					
	Potočnik, I., Pentek, T. & D. Pičman, 2005: Traffic characteristics on forest roads due to forest management, Croatian Journal of Forest Engineering 26 (1), Zagreb, Croatia, str. 51-57.					

	Frisk, M., Karlsson, J., Rönnqvist, M. 2006: Roadopt – A decision support system for road upgrading in forestry. Scand. J. For. Res. 21 (Suppl. 7), p. 5–15.
	Henningsson, M., Karlsson, J., Rönnqvist, M. 2007: Optimization Models for Forest Road Upgrade Planning. J Math Model Algor (2007) 6, p. 3–23.
	Pentek, T., Nevečerel, H., Pičman, D., Poršinsky, T. 2007: Forest Road Network in the Republic of Croatia – Status and Perspectives. Croatian Journal of Forest Engineering 28(1), p. 93–106.
	Krč, J., Beguš, J. 2013: Planning Forest Opening with Forest Roads. Croatian Journal of Forest Engineering 34(2), p. 217–228.
	Pentek, T., Đuka, A., Papa, I., Damić, D., Poršinsky, T., 2016: Elaborat učinkovitosti primarne šumske prometne infrastrukture – alternativa studiji primarnog otvaranja šuma ili samo prijelazno rješenje? Šum. list 140(9–10): 435–453.
	Đuka, A., Grigolato, S., Papa, I., Pentek, T., Poršinsky, T., 2017: Assessment of timber extraction distance and skid road network in steep karst terrain. iForest – Biogeosciences and Forestry 10: 886–894.

1. GENERAL DATA			
1.1. Name of the course	Computer-Aided Design of Forest Roads	1.6. Course teacher(s)	Prof. Tibor Pentek, PhD Assist. Prof. Ivica Papa, PhD
1.2. Name of the module (if applicable)	FOREST ROAD INFRASTRUCTURE	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/tibor-pentek/ https://www.sumfak.unizg.hr/en/about/general-information/staff/ivica-papa/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	8 + 8 + 8
1.4. No. of the course	30	1.9. ECTS credits	7
1.5. Code of the course	DST11	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Through this course, students gain knowledge and skills for scientific research and practical activities in the field of forest road design. Students get acquainted, theoretically and practically, with both sub-phases of forest road routing by direct and indirect routing method. Theoretical knowledge is transferred through verbal and visual methods, and practical knowledge is acquired through field measurements with different measuring instruments and methods of work and subsequent data processing and development of the main forest road design using several computer programs.		
2.2. Course contents (syllabus)	Students gain knowledge about different methods of routing forest roads (field collection of all data necessary for the development of the main / implementation design of the forest road), data processing and design development using computers and special software programs. A historical overview of the development of different methods of data collection by field measurements is presented, along with a description and explanation of instruments and devices that have been or are still being used. Today's modern methods of field surveying are also elaborated in detail, and an implementation protocol is given for each of them. The development of the forest road design process is explained, from the classical design method, through the very beginnings of the introduction of computer-aided design methods, to the current achievements in this field. An overview is given of various computer programs used today in Croatia and in the world for the design of forest roads with an emphasis on their advantages and disadvantages. During the practical exercises, doctoral students use selected, specialized computer programs to create a specific forest road design, based on data collected by independent field survey, going through all phases of work: data entry into a personal computer, data processing, printing and plotting numerical and		

	graphical data, etc. The process of creating each of the components of the main design of the forest road is presented in detail with an emphasis on theoretical settings, prescribed technical features and legal frameworks in order to achieve an optimal design solution.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Analyze and critically review computer programs for the design of forest roads 2. Explain the staking out of the main points and staking mehods of detailed points of horizontal curves, transition curves and serpentines; describe the detailed construction features of cross sections of a specific road 3. Explain the longitudinal section, cross section and road bed of the forest road 4. Recommend facilities for securing / protecting the forest road bed and drainage facilities 5. Assess the pavement structure and causes of damage to forest roads

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☒	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Šikić, D. i drugi 1989: Tehnički uvjeti za gospodarske ceste, Znanstveni savjet za promet JAZU, Zagreb, str. 1-40.
	Korlaet, Ž., 1995: Uvod u projektitanje i građenje cesta. Sveučilište u Zagrebu, str. 1-208.
	Babić, B. 1997: Projektiranje kolničkih konstrukcija. Hrvatsko društvo građevinskih inženjera, str. 1-197.
	FAO 1998: Manual for the planning, design and construction of forest roads in steep terrain, Food and Agriculture Organisation of the United Nations, Rome, p. 1-188.
	ROADENG, 1998. Users manual, Softree, CANADA.
	Kramer, B.W., 2001: Forest road contracting, construction, and maintenance for small forest woodland owners. Research. Contribution 35: Oregon State University, College of Forestry, Forest Research Laboratory; Corvallis, OR, p. 1- 79.
4.2. Additional literature	Lacrombe, G., 1999: Forest Roading Manual, Liro Forestry Solutions, New Zeland, p. 1-404, odabrana poglavlja.
	Anon., 2002: Forest Road Engineering Guidebook, B.C. Ministry of Forests, p. 1-208, odabrana poglavlja.

	Heralt, L., 2002: Using the ROADENG system to design an optimum forest road variant aimed at the minimization of negative impacts on the natural environment. Journal of forest science, 48 (8), str. 361–365
	Dragčević V., Korlaet Ž., 2003: Osnove projektiranja cesta, udžbenik, Građevinski fakultet Sveučilišta u Zagrebu, s. 1-93,
	Ryan, T. et al., 2004: Forest Road Manual, Guidelines for the design, construction and management of forest roads, COFORD, Dublin, p. 1-156, odabrana poglavlja.
	Robek, R., Klun, J., 2007: Recent developments in forest traffic way construction in Slovenia. Croatian Journal for Forest Engineering 28(1), str. 83-89.
	Lepoglavec, K., Potočnik, I., Pentek, T., Tomašić, Ž., Poje, a., Mihelič, M., 2011: Programski paket za projektiranje šumskih prometnica »RoadEng«. Nova mehanizacija šumarstva 32 (1), str. 39-51.
	Anon., 2011: Colorado Forest Road Field Handbook, Colorado State Forest Service, p. 1-142, odabrana poglavlja.

1. GENERAL DATA			
1.1. Name of the course	Technical and environmental suitability of forest machines	1.6. Course teacher(s)	Prof. Marijan Šušnjar Assist. Prof. Zdravko Pandur
1.2. Name of the module (if applicable)	FOREST TECHNIQUES	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/marijan-susnjar/ https://www.sumfak.unizg.hr/en/about/general-information/staff/zdravko-pandur/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6+6+12
1.4. No. of the course	31	1.9. ECTS credits	7
1.5. Code of the course	DST18	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to acquaint students with the essential components of the environmental performance of forest machinery, the basic principles of construction and development of forest machinery, methods of laboratory and in situ measurement, based on which they can quantify their technical and environmental suitability. Special attention is paid to the technical, ergonomic, energy and environmental characteristics of machines of state-of-the-art wood extraction technologies.		
2.2. Course contents (syllabus)	Doctoral students are introduced to the technical, constructional and operational characteristics of forest machinery important for their environmental friendliness - the emission of harmful gases and particles from vehicle exhaust systems, the use of toxic liquids and the impact on forest soil. In addition, they get acquainted in detail with the development, basics and classification of the most important forest machines for mechanization of wood extraction works; principles and guidelines of their construction as well as their most important technical, energy, environmental and ergonomic features. Special attention is paid to the latest technical achievements and the current stage of development of the construction of entire machines as well as their essential components - transmissions, hydraulic systems, etc. and forestry devices such as hydraulic cranes, forest winches, etc. SUI engines are mostly used as forestry drive devices. two-stroke petrol for the operation of chainsaws and diesel engines for forest vehicles (tractors), so doctoral students are introduced to the legal regulations on limiting emissions, as well as trends, design solutions (eg 4-mix engine) and the use of special fuels (biodiesel, special mixtures for two-stroke engines) for the purpose of reducing emissions. As hydraulic systems are used in most forest		

	vehicles, the introduction of biodegradable hydraulic fluids as well as biodegradable lubricating oils (especially for lubricating chainsaw chains) is an important part of the subject. Moving on the stand, forest vehicles load the forest soil, so the basic principles of force transfer from the wheels to the ground are studied, with special reference to the negative effect (track, trampling and compaction). In the practical part, based on the dynamic load of the vehicle, the dimensions of the movement system and the physical properties of the soil, wheel indices and contact pressures are calculated for the purpose of assessing technical and environmental suitability. The course provides knowledge on the development of new energy sources and propulsion in modern generations of forest vehicles that are encouraged by European regulations. Students will be introduced to technical solutions for the construction of alternative drives, basic features, production and operating principles of different types of energy tanks, the possibility of using new generations of forest vehicles in forest works to judge their environmental, energy and ergonomic suitability.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Recommend the use of forest vehicles for certain habitat conditions in order to perform work in a safe, efficient and environmentally friendly manner 2. Assess damage to forest soil and stands due to the movement of forest vehicles 3. Create boundary conditions for the application of a particular forest vehicle 4. Choose the optimal alternative drives for different types of forest vehicles and perform forest works

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes						
	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Nokka, J., 2018: ENERGY EFFICIENCY ANALYSES OF HYBRID NON-ROAD MOBILE MACHINERY BY REAL-TIME VIRTUAL PROTOTYPING Acta Universitatis Lappeenrantaensis 785, 1-87.
	Finpro, 2010: Ev technologies in working machinery – Global view. 1-62

	Hellström, T., Ringdahl, O., 2011: Intelligent vehicles in forestry. Umeå University. 1-46.
	Anttila, T., 1998: Predicting the rut formation in forest soils by use of the WES method. Department of Forest Resource Management University of Helsinki, Publications 17, 1 – 53.
	Wong, J., Y., 2001: Theory of ground vehicles. J. Wiley $ sons Inc. USA. 1-528.
	Rieppo, K., Kariniemi, A., Haarlaa, R., 2002: Possibilities to develop machinery for logging operations on sensitive forest sites. Department of forest resource management, University of Helsinski, Finland, Publications 29, 1-30.
4.2. Additional literature	Arnup, R.W., 1998: The extent, effect and management of forestry-related soil disturbance, with reference to implications for the Clay Belt: a literature review. Ontario Ministry of Natural Resources, Northeast Science & Technology, TR-37, 1 – 30.
	Georgsson F., Hellström, T., Johansson, T., Prorok, K., Ringdahl, O. and Sandström, U., 2005: Development of an Autonomous Path Tracking Forest Machine- a status report. Technical Report UMINF 05.08, Department of Computing Science, Umeå University SE-901 87 Umeå, Sweden.
	La Hera, P.,Mendoza Trejob, O., Ortíz Moralesa D., 2018: AUTOMATION TECHNOLOGY FOR FORESTRY MACHINES: A VIEW OF PAST, CURRENT, AND FUTURE DEVELOPMENTS. Proceedings 6 th International Forest Engineering Conference “Quenching our thirst for new Knowledge” Rotorua, New Zealand, April 16th - 19th, 2018. 1-9.
	Laitila, J., Prinz, R., Routa, J., Kari Kokko, L., Kaksonen P., Suutarinen,J., Eliasson, L., 2015: PROTOTYPE OF HYBRID TECHNOLOGY CHIPPER. Skogforsk INFRES – 1-20.
	Owende, P. M. O., Lyons, J., Haarlaa, R., Peltola, A., Spinelli, R., Molano, J., Ward, S. M., 2002: Operations protocol for Eco-efficient Wood Harvesting on Sensitive Sites. Project ECOWOOD, Funded under the EU 5th Framework Project (Quality of Life and Management of Living Resources) Contract No. QLK5-1999-00991 (1999-2002), 1 – 74.
	Saarilahti, M., 2002: Soil interaction model. Project deliverable D2 (Work package No. 1) of the Development of a Protocol for Ecoefficient Wood Harvesting on Sensitive Sites (ECOWOOD). EU 5th Framework Project (Quality of Life and Management of Living Resources) Contract No. QLK5-1999-00991 (1999-2002), 1 – 87.
	Inoue, M., Tsujii, T., 2003: Management, technology and system design of mechanized forestry in Japan. Textbook of forestry mechanization technology, Forestry Mechanization Society, Akasaka, Minato-ku, Tokyo, Japan, Forestry Machine Series No. 92, 1-122.
	Šušnjar, M., 2005: Istraživanje međusobne ovisnosti značajki tla traktorske vlake i vučne značajke skidera, disertacija, Šumarski fakultet Sveučilišta u Zagrebu, 1 – 146.

1. GENERAL DATA			
1.1. Name of the course	Ergonomy in forestry	1.6. Course teacher(s)	Prof. Marijan Šušnjar
1.2. Name of the module (if applicable)	FOREST TECHNIQUES	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/marijan-susnjar/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	6+8+10
1.4. No. of the course	32	1.9. ECTS credits	7
1.5. Code of the course	DST19	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Students acquire knowledge about ergonomic and safety features of forest machines and ways and procedures of measuring ergonomic features with modern measuring equipment with interpretation of results in order to make decisions and guidelines on the operation of forest machines in an ergonomically acceptable way.		
2.2. Course contents (syllabus)	Determining the spatial parameters of the workplace The impact of the work environment on the worker. Workload of forestry workers. Generation of noise and vibration. Expression of noise and vibration levels. Influence of noise and vibration on man. Possibilities of measuring noise and vibration levels, intensity, frequency characteristic, evaluation procedure. Standards (ISO, EU and HR) for noise and vibration measurements. Noise during operation of forest machines and vehicles Measurement of vibrations transmitted to the hand - hand system and their evaluation. Vibrations transmitted to the whole body in the transverse direction and their evaluation. Vibrations transmitted to the whole body in the longitudinal direction and their evaluation. Harmful effects of gases and dust. Procedure for measuring the concentration of gases and dust and expressing their concentration. Special influences. Work environment light. Ergonomic design of working space, cabin and construction of forest vehicles. FOPS, ROPS and OPS forest vehicles. Standards governing the ergonomic and safety features of forestry machinery.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Identify and analyze the most important ergonomic requirements and hazards in the operation of forest machines. 2. Analyze the vibration values of forest machines after many years of use in forest works. 3. Choose the most ergonomically friendly forest machine based on the manufacturer's data on tests performed according to the requirements of ISO standards. 4. Evaluate forest vehicles according to ergonomic tests.		

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Gellerstedt, S., Lidén, E., Bohlin, F., 2005: Health and Performance in Mechanised Forest Operations. Editors: Sten Gellerstedt, Swedish University of Agricultural Sciences. A handbook produced by ErgoWood, a project co-financed by the European Commission Swedish University of Agricultural Sciences, Uppsala, Sweden, 1-45.
	Almqvist, R. Gellerstedt, S., Tobish, R. , 2005: Ergonomic Checklist for Forest Machines. A handbook produced by ErgoWood, a project co-financed by the European Commission Swedish University of Agricultural Sciences, Uppsala, Sweden, 1-23
	EU-OSHA, 2008: Occupational safety and health in Europe's forestry industry. European agency for safety and health at work. https://osha.europa.eu/en/publications/e-facts/efact29/view. 1-13.
	Gellerstedt, S., Eriksson, G., Frisk, S., Hultåker, O., Synwoldt, U., Tobish, R. Weise, G., 2006: European ergonomic and safety guidelines for forest machines. A handbook produced by ErgoWood, a project co-financed by the European Commission Swedish University of Agricultural Sciences, Uppsala, Sweden, 1-101.
	Lewark, S., 2005: Scientific reviews of ergonomic situation in mechanized forest operations. Swedish University of Agricultural Sciences, Uppsala, Sweden, 1-182.
	Tobisch, R., Hultåker, O., Walkers, M., Weise, G., 2005: Improvements of ergonomic assessment procedures for forest machines. Swedish University of Agricultural Sciences, Uppsala, Sweden, 1-62.
4.2. Additional literature	Directive 2002/44/EC Of the European Parliament and of the Council: The mimimum health requirement regarding the exposure of workers to the risks arising from physical agents (vibration). Official Journal of the European Communities, 177.p.

	Horvat, D., Šušnjar, M., 2003: Temeljni sigurnosni i tehnički zahtjevi ISO normi za konstrukciju skidera, studija u okviru projekta "Razvoj, izrada i ispitivanje prototipa specijalnog šumskog vozila - skidera mase 7t", programa TEST Ministarstva znanosti, obrazovanja i športa RH, 1-98.
	HRN ISO norme koje definiraju sigurnosne zahtjeve na šumske strojeve
	FAO, 1992: Introduction to ergonomics in forestry in developing countries to ergonomics in forestry in developing countries
	Stanton, N., Hedge, A., Brookhuis, K., Salas, E., Hendrick, H., 2005: Handbook of Human Factors and Ergonomic Methods
	Kaljun, J., Dolšak, B., 2012: Ergonomic design recommendations based on an actual chainsaw design
	Skogforsk, 1999: Ergonomic guidelines for forest machines

1. GENERAL DATA			
1.1. Name of the course	Forestry management	1.6. Course teacher(s)	Full professor Ivan Martinić, PhD Full professor Mario Šporčić, PhD
1.2. Name of the module (if applicable)	Organization and management in forestry	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	8+6+10
1.4. No. of the course	33	1.9. ECTS credits	7
1.5. Code of the course	DST7	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Introduce doctoral student to the principles and role of management in modern forestry, especially in global challenges (climate change, biodiversity loss, management and sustainability of natural resources, rural development, etc.) and green economic transformation (bioeconomy, green infrastructure, gren jobs, renewable energy sources, etc.) . Develop doctoral student's ability to holistically consider the role of entrepreneurship in the current global transformation of the forestry sector and strengthen student to participate in strategic, tactical and operational decisions at various levels of the forest organization. Equip doctoral student with practical skills in solving complex issues related to key management functions: decision making and planning, financing, organizing and leading, controlling, reporting and evaluation.		
2.2. Course contents (syllabus)	(I.) The concept and characteristics of modern forestry. The role of forestry management in global challenges and programs (climate change, biodiversity loss, natural resource management, rural development, etc.); (II.) General and specific goals, tasks and expected social effects of forestry management. Transformation of the global economy - bioeconomy, green infrastructure, green jobs, renewable energy sources, etc. (III.) Forestry entrepreneurship - goals, opportunities and sustainable entrepreneurial niches. Preparation and adoption of strategic, tactical and operational decisions in various areas of the forestry sector. (IV.) Key elements of successful entrepreneurship: innovation, discovery of favorable opportunities, market orientation, development of special skills, transfer and application of modern technologies.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	(1) understand and explain the features of modern forestry management in relation to global challenges and the transformation of the classical economy; (2) master the techniques of environmental analysis and goal definition and assessment of the overall (economic, environmental and social) impact of management measures, (3) apply theoretical knowledge in the operational solution of tasks in planning, organizing and managing and controlling and evaluating entrepreneurial projects; (4) devise strategies to strengthen the competitiveness of the forestry sector in relation to		

	applications for entrepreneurial projects under EU financial programs and instruments; (5) apply convincing expert arguments and the best practice examples in the protection of sectoral interests in cross-sectoral action and positioning.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☒	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☒	Written exam	☒		
4. LITERATURE LIST						
4.1. Obligatory literature	Schmithüsen, F., Kaiser, B., Schmidhauser, A. Mellinnghoff, S., Kammerhofer A.W., 2006: Poduzetništvo u šumarstvu i drvnoj industriji – Osnove menadžmenta i poslovanja. CID EF Beograd					
	**grupa autora: Management i poduzetništvo (ur. Ivo Vajić). Centar za poduzetništvo Zagreb – Mladost, Zagreb 1994.					
	Zakon o šumama (NN, integralni i pročišćeni tekst)					
	Moiseev, N.A., von Gadow, K., Krott, M.: Planning and Decision Making for Forest Management in the Market Economy. IUFRO Division 3. Pushkino/Goetingen, 1997.					
4.2. Additional literature	* group of authors: Projekti i projektni menadžement (Projects and project management) . Zbornik radova međunarodne konferencije Zaprešić/Zagreb 25-26. 2. 2011. VSPU Baltazar Adam Krčelić, Zaprešić 2011.					
	Sikavica, P., Bahtijarevic-Šiber, F., Pološki Vokić, N.: Temelji menadžmenta. Školska knjiga Zagreb. Zagreb 2008.					
	Martinić, I.: Upravljanje zaštićenim područjima prirode – planiranje, razvoj i održivost, Zagreb 2010.					
	Martinić, I., Dekanić, S.: Vizija šumarstva 2050. godine - skupno promišnjanje budućnosti šumarstva eksperata FAO (1 i 2): Hrvatske šume, br. 94, 95. Zagreb, 2004.					
	Buble, M.: Osnove menadžmenta, Sinergija nakladništvo, Zagreb 2006.					

1. GENERAL DATA			
1.1. Name of the course	Corporative governance	1.6. Course teacher(s)	Prof. dr. sc. Stjepan Posavec
1.2. Name of the module (if applicable)	Organization and management in forestry	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/stjepan-posavec/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	8+0+16
1.4. No. of the course	34	1.9. ECTS credits	7
1.5. Code of the course	DST15	1.10. Language(s)	Croatian ☒ English ☐

2. COURSE DESCRIPTION	
2.1. Course objectives	The task of teaching this course is to acquaint students with the theory and practice of various aspects of corporate governance, and for their competent orientation in modern business. To study the possibilities, rights and responsibilities of different participants and their positions in corporate governance.
2.2. Course contents (syllabus)	The course deals with topics related to various aspects of corporate governance. It deals with the importance of corporate governance and types of corporations in the field of forestry and wood processing. Why corporate governance is good for society. OECD principles and legislative framework for corporate governance. Duties of the supervisory board and management. Composition and characteristics of effective supervisory boards. Warning signs of company's problems. Participation in the fundamental decisions of the corporation. The role of different stakeholders in corporate governance. Customer relations. Economic, environmental and social responsibility of companies in forestry and wood processing. Open and closed corporate governance systems. The role of forestry in achieving the goals of sustainable management of the UN (SDG). Goals and strategies of sustainable economic growth and development in the Republic of Croatia.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. To analyse different aspects of corporate governance. 2. To present principles and legislative framework of governance. 3. To compare specifics of business performance in forestry and wood processing industry. 4. To estimate the role of forestry and wood industry in national economy.

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐

evaluation of achieved learning outcomes	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Organisation for Economic Co-operation and Development (OECD), 2004: OECD Principles of Corporate Governance, Organisation for Economic Cooperation and Development, Paris					
	Posavec, S; Beljan, K; Šporčić, M; Landekić, M. (2012):Corporate Governance In Forestry. Wood and Furniture Industry in Times of Change - New trends and Challenges Trnava, 18-19					
	Figurić, M.: UVOD U EKONOMIKU ŠUMSKIH RESURSA, Šumarski fakultet, Zagreb, 1998					
	Figurić, M.: MENADŽMENT TROŠKOVA U DRVNOTEHNOLOŠKIM PROCESIMA, izabrana područja, Šumarski fakultet, Zagreb,					
	Tipurić, D. (2008): Korporativno upravljanje, Sinergija nakladništvo d.o.o., Zagreb					
4.2. Additional literature	Kajanus, M.; Leban, V.; Glavonjic, P.; Krc, J.; Nedeljkovic, J.; Nonic, D.; Nybakk, E.; Posavec, S.; Riedl, M.; Teder, M.; Wilhelmsson, E.; Zalite, Z.; Eskelinen, T.: What can we learn from business models in the European forest sector: Exploring the key elements of new business model designs. FOREST POLICY AND ECONOMICS, 2019. volume 99, 145-156					

1. GENERAL DATA			
1.1. Name of the course	Anatomical structure of wood	1.6. Course teacher(s)	Prof. Jelena Trajković, PhD Assoc. Prof. Bogoslav Šefc, PhD
1.2. Name of the module (if applicable)	The science of wood	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/jelena-trajkovic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/bogoslav-sefc/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	15 + 10 + 10
1.4. No. of the course	35.	1.9. ECTS credits	7
1.5. Code of the course	DDT 201	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Show overview of: - anatomical structure of wood and bark, and the formation of wood and bark of commercial species of conifers and deciduous trees. - peculiarities and variation of the anatomical structure of wood between species, between trees of the same species and within a tree. - method for researching the anatomical structure of wood. - scientific and professional papers on the properties of the anatomical structure of wood selected according to the preferences of each student (eg purposefully supplementing the topic of the selected doctoral research)		
2.2. Course contents (syllabus)	Macroscopic, microscopic and submicroscopic structure and ontogenesis of wood and bark of commercial tree species in Croatia and Europe. Variations in the anatomical structure of wood and details important in recognizing certain types of wood. Measuring instruments and methods for observing and recording the anatomical structure of wood. Factors of variations in the anatomical structure of wood. Natural irregularities in the anatomical structure of wood. Influence of wood anatomical structure on other properties of wood. Wood identification, wood identification keys, organization, use, management and maintenance of the wood library - xilarium.		

	The course includes basic knowledge of the above content with a special upgrade of selected parts that will be supplement to a doctoral research of an individual student.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Select those properties of the anatomical structure of wood that will be supplement to the doctoral research of an individual student. 2. Select appropriate methods to investigate the properties of the anatomical structure of wood listed under 1). 3. A) Research and analyze scientific and professional papers on the properties of the anatomical structure of wood listed under 1); B) Optionally and depending on the available time, perform a laboratory experiment / measurement on the topic listed under 1). 4. Report the above research and analysis (optional laboratory test / measurement) in the form of a critical review.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☐
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Gardiner, B.; Barnett, J.; Saranpää, P.; Joseph Gril, J. (Editors), (2014): The Biology of Reaction Wood, Springer-Verlag Berlin
	Hacke, U. (Editor), 2015: Functional and Ecological Xylem Anatomy. Springer Cham Heidelberg New York Dordrecht London,
	Schoch,W.,Heller,I.,Schweingruber,F.H.,Kienast,F., (2004):Wood anatomy of central European Species. Online version:
	Timell, T.E., (1986): Compression Wood in Gymnosperms I. Springer Verlag Berlin Heidelberg. 706 str.
	Zobel, Bruce J., Buijtenen, Johannes P. van, (1989): Wood Variation: Its Causes and Control. Springer Series in Wood Scinece
	Yoon Soo Kim, Ryo Funada, Adya P. Singh. (editors), (2016): Secondary Xylem Biology, Origins, Functions, and Applications
4.2. Additional literature	Zimmermann, M.H.; Brown C.L., (1971): Trees Structure and Function, Springer Verlag, 1971. 336 str.

1. GENERAL DATA			
1.5. Name of the course	VALUATION AND USE OF WOOD	1.6. Course teacher(s)	full. prof. Tomislav Sinković, PhD assist. prof. Tomislav Sedlar, PhD
1.6. Name of the module (if applicable)	WOOD SCIENCE	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/tomislav-sinkovic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/tomislav-sedlar/
1.9. Status of the course	obligatory course	1.8. Structure of teaching (number of hours: L + E + S)	15 + 10 + 10
1.10. o. of the course	36	1.9. ECTS credits	7
1.11. ode of the course	152248	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.7. Course objectives	A scientific study of macroscopic, aesthetic, physical, mechanical and technological wood properties.		
2.8. Course contents (syllabus)	Research and determination of macroscopic, physical and mechanical properties of wood. The elemental composition of wood and its influence on wood properties, wood composition as a factor of wood properties, cross-section properties of wood, sapwood and heartwood, classification, coring, theory of the coring process, annual ring width, early and late wood and proportion of late wood, fineness of wood, colour and wood shine, wood odour, wood texture. Wood matter density, wood density, wood density determination procedures, wood density factors, density distribution in tree and wood. Binding of water to wood, free and bound water in the wood, the moisture content in wood, distribution of water in wood and wood products, moisture gradient in wood, types of moisture gradient in wood, adsorption and desorption, hygroscopic balance, fibre saturation point, the highest water content in wood, tension and swelling, anisotropy of tension and swelling. Expansion, the specific heat of wood, heat conductivity in wood, wood heating power, the durability of wood, electrical conductivity of wood, dielectric and piezoelectric properties of wood, speed and resistance of sound in wood, damping and resonance of sound in wood. Hooke's law. Tension strength of wood. Compressive strength of wood. Bending strength of wood. Twisting strength of wood. Splitting strength of wood. Impact strength of wood. Wood hardness. Resistance of wood against wear. Modulus of elasticity of wood. Wood quality coefficients. Anisotropy of mechanical properties of wood. Factors		

	of mechanical properties of wood. Creep of wood, primary, secondary, elastic and plastic deformations, highly flexible wood properties. Rheological models and theoretical considerations of the rheological properties of wood, the influence of wood type, density, wood defects, temperature, water content, and microclimatic conditions on the rheological properties of wood. The behaviour of wood over time as an important factor when using wood as a material. Stresses and deformations during long-term loads and comparison with deformations for short-term loads. Research and determination of macroscopic, physical, mechanical and technological properties of wood for the tree of one type of wood. Evaluation of models for determining wood properties from one or more locations. Determining the distribution of wood properties within one tree. Determination and analysis of the properties of one type of wood from different localities. Comparison and analysis of properties of different types of wood from one or more localities. Creation of models that enable the analysis of wood properties essential for its use. Analysis and determination of the primary wood properties that satisfy a certain type of use. Analysis and determination of the specific properties of wood that can positively or negatively affect the use of wood for a certain type of use. Analysis of the wood properties, which are the comparative advantage of wood in a certain type of use. Analysis of the wood properties that narrow the area of use of wood. Determination, analysis and evaluation of the properties of modified wood in use. Preparing and researching short-term and long-term experiments on wood behaviour in a certain type of use. Analysis and assessment of destructive and non-destructive methods for determining the properties of wood in use. Analysis and evaluation of the wood properties used to a greater or lesser extent in construction materials.
2.9. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. A scientific approach to planning and researching macroscopic, aesthetic, physical, mechanical and technological properties of wood. 2. Selection of trees, middlings, and sawdust for making samples for researching wood properties. 3. Creation, sorting and preparation of samples for research. 4. Examine samples for research on macroscopic, aesthetic, physical, mechanical and technological properties of wood. 5. Statistical processing of research results. 6. Interpretation of research results. 7. Preparation of research results for publication.
3. MONITORING AND EVALUATION OF STUDENT WORK	

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☒	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Kollmann,F.P.1968:Principles of Wood Science and Technology, I Solid Wood, Berlin, str.79-551.
	Giordano, G.1971: Tecnologia del legno, Volume l, Torino, str. 671-924.
	Tsoumis, G.1991: Science and Technology of Wood, New York,str. 1-233.
4.2. Additional literature	Govorčin,S.; Sinković,T. (2000): Influence of double sapwood on the quality of Slavonian oak. "IUFRO Working groups: Improvement of wood quality and genetic diversity of oak" Glasnik za šumske pokuse, 37 (189-199).
	Govorčin, S., Sinković, T., Despot, R., Trajković, J., Šefc, B. (2001): Old-new types of wood in furniture production. International conference "WOOD-FUTURE MATERIAL IN FURNITURE DESIGN" str.89-96, Zagreb.
	Govorčin,S.,Sinković,T.,Despot,R.(2006):Distribution of plastic strains in fir-wood at static bending. Wood research, 51(2)87-95.
	Sinković , T., Govorčin ,S., Dubravac ,T., Roth ,V.,Sedlar,T.,2009: Usporedba tehničkih svojstava abonosa i recentnog drva hrasta lužnjaka (Quercus robur L.). Šumareski list CXXXIII (2009)(11-12)569-576.
	Kličić,H.,Govorčin,S.,Sinković,T.,Gurda,S.,Sedlar,T.,2011:Makroskopske karakteristike i gustoća drva bijelog bora (Pinus sysvestris L.) s područja Cazina u Bosni i Hercegovini. Šumareski list CXXXV (7-8) 371-377.
	Sinković,T.,Govorčin,S.,Sedlar,T.,2012:Comparision of physical properties of heat treated and untreated hornbeam wood,beech wood, ash wood and oak wood.The 5-nd International Symposium "Hardwood research and utilization in Europe 2012", Volume 1., str. 63-70, Sopron.
	Govorčin, S.; Sinković, T.; Trajković, J.;Despot, R.(2003): Obična bukva u Hrvatskoj. Akademija šumarskih znanosti i Hrvatske šume. Zagreb, poglavlje "Bukovina" 652-669.
	Sinković,T.,Govorčin,S.,Sedlar,T.,2011:Usporedba fizikalnih svojstava neobrađene i toplinski obrađene bukovine i grabovine. Drvna industrija, 62(4)283-290.

1. GENERAL DATA			
1.1. Name of the course	Modification of Solid Wood	1.6. Course teacher(s)	Assoc. Professor Marin Hasan, PhD
1.2. Name of the module (if applicable)	Wood Modifications	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/hasan-marin/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	15 + 10 + 10
1.4. No. of the course	37	1.9. ECTS credits	7
1.5. Code of the course	DDT 203	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1. Introduce students to the idea of modifying the properties of wood and ways to modify the properties of wood. 2. The student will choose one or two types of modification and in the laboratory the modification mode will be optimized, the tree will be modified while monitoring the course of the modification procedure. 3. Upon completion of the modification process, the modified wood will be tested for the desired chemical, physical, mechanical and / or biological properties. 4. Students will independently write a report / expertise on the modification process and the tested properties of wood.		
2.2. Course contents (syllabus)	Modification of wood properties - wood properties and wood modification; wood modification methods; wood cell wall; Chemical composition of wood; Hygroscopic properties of wood; Mechanical properties of wood; Modified wood and biodegradation; Wood and aging; Proving new connections. Chemical modification of wood - Reactions; Cell wall reactivity; Modified wood analyzes; Dimensional stability; Mechanical properties; Microbiological decay; Biological degradation by insects and marine pests; Properties of modified wood; Composite materials composed of modified wood. Chemical modification of wood with the following chemicals: non-cyclic anhydrides, cyclic anhydrides, carboxylic acids, etc., formaldehyde and nonformaldehyde chemicals.		

	Thermal modification of wood - process variables; chemical changes of wood due to thermal modification; Physical changes of wood due to thermal modification; Biological properties of thermally modified wood; Compressed wood; Oil-Heat-Treatments; Vacuum treatments. Impregnation modification - Resin processes; Impregnations with silicone-containing components; Other methods of saturating the cell wall with inorganic substances; Cell wall impregnation with monomers; Cell wall impregnation with polymers. Commercialization of wood modification - Thermal modification; Oil-Heat-Treatment processes; Acetylation; Impregnation modification. Consideration of wood modification from the environmental point of view - Principles and methods of determining the impact on the environment; Impact of wood modification on the environment; Industrial ecology and wood modification; The future of wood modification. Types and parameters of solid wood modification. Properties of modified solid wood. Possibilities (advantages and disadvantages) of existing and newer modification procedures from the aspect of prolonging the service life of wooden products. The role and importance of domestic wood species in different modification procedures. Exercises: Optimizing and monitoring the course of modification proccess in laboratory conditions. Tests of wood properties in the process and after modification.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Students will learn the basic advantages and disadvantages of different wood modification procedures. 2. The student will learn the influence of individual modification parameters on the properties of the modified wood. 3. The student will be able to independently choose a certain type of modification for a certain (specific) use. 4. The student will be able to independently examine the basic physical and mechanical properties of modified wood. 5. The student will be able to write and present a concrete project solution with a modified wood.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐

	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☒	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Hill, C. 2006: Wood modification - chemical, thermal and other processes. John Wiley & sons Ltd, Chichester, UK.					
	David, N.; Hon, S., 1996: Chemical modification of lignocellulosic materials. Marcel Dekker, Inc. New York-Basel-Hong Kong					
	Militz, H.; Hill, C. (editors) 2005 – 2020: Wood modification: processes, properties and commercialisation. Proceedings of The					
	European Conferences on Wood Modification.					
	David, N.; Hon, S., 1991: Wood and cellulosic chemistry. Marcel Dekker, Inc. New York					
4.2. Additional literature	Articles from the International Conferences on: Internationa Research Group on Wood Protection IRG-WP (from the base):					
	https://www.irg-wp.com/search-irg-docs.html articles on wood modification					

1. GENERAL DATA			
1.1. Name of the course	Modification and durability of wood surface	1.6. Course teacher(s)	Prof. Hrvoje Turkulin, PhD; Prof. Vlatka Jirouš-Rajković, PhD
1.2. Name of the module (if applicable)	Wood modifications	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/hrvoje-turkulin/ https://www.sumfak.unizg.hr/en/about/general-information/staff/vlatka-jirous-rajkovic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	15+10+10
1.4. No. of the course	38	1.9. ECTS credits	7
1.5. Code of the course	DDT 204	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	To acquaint students with the factors that affect the durability of wood and methods of testing the durability of the wood surface. To acquaint students with the latest knowledge and methods of wood surface modification.		
2.2. Course contents (syllabus)	Factors affecting wood durability of wood surface. Methods of testing the durability of the wood surface. Possibilities of increasing durability of wood surface. Methods of surface modification of wood. Thin strips method. Chemical modification of wood surface (acetylation, furfurylation, modification with dimethyloldihydroxyethylene urea - DMDHEU, modification with citric acid and other agents used in the textile industry, modification with hydrophobic agents). Modification of wood surface by radiation. Wood surface modification by mechanical treatments. Application of nano technology and nano materials in wood surface modification. Quality testing of modified surfaces.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Students will be able to create and critically evaluate new scientific facts and insights in the field of durability and modifications of wood surface; 2. to analyze, interpret and critically reflect on new research problems in the field of durability and modification of wood surface; to analyze existing research methods and create new ones; to write a seminar paper in the field of wood surface modifications		
3. MONITORING AND EVALUATION OF STUDENT WORK			

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Petrič, Marko: Surface Modification of Wood. Reviews of Adhesion and Adhesives, Number 2 / April 2013, pp. 216-247(32)
	Hill, C.A.S. Wood Modifi cation: Chemical, Thermal and Other Processes, John Wiley & Sons, Chichester, England (2006).
	Jirouš-RajkoviĆ, V., Miklečić, J.: Enhancing Weathering Resistance of Wood—A Review. Polymers (13), 2021.
	Evans, P.D.; Wallis, A.F.A.; Owen, N.L. Weathering of Chemically Modified Wood Surfaces. Wood Sci Technol 2000, 34.
	Homan, W.J.; Jorissen, a.J.M.: Wood modification developments. HERON, Vol. 49 (4), 2004.
	Kumar, S. Chemical modification of wood. Wood Fiber Sci. 26, 270–280 ,1994.
4.2. Additional literature	Rowell, R. M. (Ed.), Handbook of Wood Chemistry and Wood Composites, CRC Press, Boca Raton, Florida (2005)
	Jirouš-Rajković, V.; Miklečić, J. Heat-Treated Wood as a Substrate for Coatings, Weathering of Heat-Treated Wood, and
	Coating Performance on Heat-Treated Wood. Advances in Materials Science and Engineering 2019
	Derbyshire, H.; Miller, E.R.; Turkulin, H. Investigations into the Photodegradation ofWood Using Microtensile Testing. Part 2:
	An Investigation of the Changes in Tensile Strength of Different Softwood Species during Natural Weathering. Holz Roh
	Werkst. 1996, 54, 1–6.
	Turkulin, H.; Sell, J. Investigations into the Photodegradation of Wood Using Microtensile Testing. Part 4: Tensile Properties
	and Fractography ofWeathered Wood. Holz Roh Werkst. 2001, 60, 96–105

1. GENERAL DATA			
1.1. Name of the course	Theory of wood cutting	1.6. Course teacher(s)	Prof. Ružica Beljo Lučić, PhD Assoc. Prof. Igor Đukić, PhD
1.2. Name of the module (if applicable)	Theory of mechanical woodworking	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/ruzica-beljo-lucic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/igor-djukic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	15+10+10
1.4. No. of the course	39	1.9. ECTS credits	7
1.5. Code of the course	DDT205	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to enable students to critically analyze published research results in the field of mechanical wood processing and conduct experiments to investigate the impact of input parameters on output parameters in wood cutting and determine the optimal processing parameters with respect to processing objectives and limitations.		
2.2. Course contents (syllabus)	Wood cutting theory. Research of the influence of significant input parameters of mechanical wood processing on output parameters. Measurement methods, measuring procedures and measuring systems. Possibilities of direct control of significant processing parameters. Tool blade durability test. Determining the form of blunting. Consequences of certain forms of blunting on the overall efficiency of working machines for mechanical woodworking. Procedures for selecting optimal processing parameters on working machines for mechanical wood processing. Defining the goals of mechanical processing and determining the function of the optimality criteria. Integral and comprehensive approach to the problem through monitoring of the machine – tool – processed workpiece – operator system. Analysis of parameters that limit the scope of possible solutions of the optimality criterion function: A) Limitations imposed by the machine: available power of the main drive motor, range of adjustable feed speed rates, feed speed power, machine stability, vibrations on the machine, their determination and consequences. Possibilities of reducing limitations. Unit price of the machine. B) Limitations imposed by the tools: durability and stability of the tools. Tools maintenance and time for their		

	replacement. Unit price of the tool. Critical frequencies. C) Limitations imposed by the processed workpiece: specific cutting resistance, quality of machined surfaces. D) Limitations imposed by the operator: safety at work, noise and vibrations, work place pollution with airborne particles and gases. E) Interaction among the influencing parameters.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	Students will be able to: 1. explain and critically review the theoretical assumptions of the wood cutting process published in the literature 2. plan and conduct an experiment to examine the influence of input parameters on the output parameters in the wood cutting process 3. measure and analyze the parameters of tool dullness depending on the conditions 4. critically analyze the published results on the impact of significant parameters of mechanical wood processing on energy consumption and processing quality indicators 5. determine the goals of mechanical wood processing and explain the choice of optimal input processing parameters taking into account the limitations imposed by the machine, tool, workpiece and machine operator

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Goglia, V., 1994: Strojevi i alati za obradu drva I, Šumarski fakultet Zagreb
	Gottlöber, C., 2014: Zerspanung von Holz und Holzwerkstoffen, Fachbuchverlag Leipzig im Carl Hanser Verlag
	Astakhov, V. P., 1998: Metal Cutting Mechanics, CRC Press
	Atkins, T., 2009: The Science and Engineering of Cutting - The Mechanics and Processes of Separating, Scratching and
4.2. Additional literature	Montgomery, D. C., 2019: Design and Analysis of Experiments, Wiley
	Astakhov, V. P., 2016: Screening (sieve) design of experiments in metal cutting, In book: Design of Experiments in Production Engineering, Edited by J.P. Davim, Springer 2016, pp. 1-37

	Orłowski, K. A., 2010: The fundamentals of narrow-kerf sawing: the mechanics and quality of cutting, Technical University in Zvolen
	Orłowski, K. A. et al. 2013: Application of fracture mechanics for energetic effects predictions while wood sawing, Wood Science and Technology 47 (5), pp. 949-963
	Đukić, I.; Jovanović, J. 2020: Energy efficiency of woodworking machines and surface roughness of machined surfaces in the secondary processing plant of Spačva d.d., Vinkovci, 31st International Scientfic Conference ICWST 2020, pp. 361-369
	Beljo Lučić, R. et al. 2006: Influence of feed speed on emission of fine sawdust during circular sawing, V. Medzinárodna vedecká konferencia Trieskové a beztrieskové obrabanie drevá 2006, pp. 49-55
	Beljo Lučić, R. et al. 2004: The influence of wood moisture content on the process of circular rip-sawing. Part I : power requirements and specific cutting forces,Wood research (Bratislava), 49 (2004), 1, pp. 41-49

1. GENERAL DATA			
1.1. Name of the course	Kinetics, modeling and optimization of hydrothermal processes	1.6. Course teacher(s)	Professor Stjepan Pervan, Ph. D. Assist. Professor Miljenko Klarić, Ph. D.
1.2. Name of the module (if applicable)	Hydrothermal proccessing of wood	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/stjepan-pervan/ https://www.sumfak.unizg.hr/en/about/general-information/staff/miljenko-klaric/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	15+10+10
1.4. No. of the course	41	1.9. ECTS credits	7
1.5. Code of the course	DDT207	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Education of an independent researcher as well as the leader of the research group on the issue of research into the kinetics of hydrothermal processes as well as their modeling in laboratory conditions, as well as transfer to production conditions and analysis of application results.		
2.2. Course contents (syllabus)	Wood-water relation, influence of pressure and temperature change on relative humidity, cell membrane and wood shrinkage and swelling, permeability, specific permeability, models applicable to wood, influence of drying on wood permeability, procedures to increase permeability, influence of water content on permeability, permeability of cell walls, permeability variations within wood species. Capillaries and water potential, surface tension, capillary tension and pressure, relation of water potential and its movement, heat conductivity, resistance and conduction, convection and radiation, uniform water movement, influence of water content and temperature on diffusion coefficient, water diffusion model in transverse direction and in the direction of the fibers, the non-uniform motion of water, the equations of the non-uniform state of water and heat, the relative value of the diffusion coefficient, the transport of liquid and heat through walls. Moisture in gases and solids (sorption and hygroscopicity of cellulosic materials). Advanced thermodynamics - chapters of heat transfer in porous bodies - molecular transfer. Water transport in wood - drying mechanism algorithm (permeability, capillarity, line potential and diffusivity). Drying intensity - critical point (fiber saturation point). Water - wood system		

	(termodynamics of sorption and hygroexpansion of wood). Energy and mass balances of continuous and discontinuous processes. Energy recovery and ways of energy savings. Stress areas in the wood drying process (influence of wood humidity, humidity gradient, temperature). Influence of inherent properties of wood on processes and quality of dried wood. Implementation of developed algorithms in measurement, automation - monitoring and changing the drying process. Chemical, morphological, physical and mechanical changes of wood in hydrothermal wood processing.					
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Setting up and modelling of the the process of hydrothermal wood treatment in laboratory conditions. 2. Introducing of optimal hydrothermal processes in production conditions on a scientific basis. 3. Analyze and optimize hydrothermal processes with respect to speed, quality and cost.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☐
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Keey, R. B., Langrish, T. A. G., Walker, J.C.F. (2000): Kiln-drying of lumber. Springer Verlag. 326 p.					
	Pervan, Stjepan: Tehnologija obrade drva vodenom parom / Zagreb : Šumarski fakultet, 2009.					
	Characterization of modified wood in relation to wood bonding and coating performance / Ljubljana : University of Ljubljana,					
	Sandberg, D., Navi, P.: Introduction to Thermo-hydro-mechanical Wood Processing / Vaxjo University, 2007					
4.2. Additional literature	Straže, Aleš; Pervan, Stjepan; Gorišek, Željko: Impact of various conventional drying conditions on drying rate and on					
	Straže, Aleš; Gorišek, Željko; Pervan, Stjepan; Froidevaux, J; Navi, Parviz. Mechano-sorptive creep of heat treated and innate					

1. GENERAL DATA			
1.1. Name of the course	Colorimetry and histochemistry of wood in hydrothermal processes	1.6. Course teacher(s)	Professor Stjepan Pervan, Ph. D. Assist. Professor Miljenko Klarić, Ph. D.
1.2. Name of the module (if applicable)	Hydrothermal processing of wood	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/stjepan-pervan/ https://www.sumfak.unizg.hr/en/about/general-information/staff/miljenko-klaric/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	15+10+10
1.4. No. of the course	42	1.9. ECTS credits	7
1.5. Code of the course	DDT208	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Education of an independent researcher as well as the leader of a research group on the issue of researching the interrelation of color changes and chemistry on wood tissues during hydrothermal processes.		
2.2. Course contents (syllabus)	Wood color, texture, aesthetic value. Physical interaction of the certain properties of wood. Wood color variability. Macroscopic level - the influence of anatomical properties. Correlation with wood density using densiometric methods. Influence of chemical structure on wood color. Cellulose, lignin, extractives (resins, polyphenols, alkaloids and inorganic salts). Induced color changes. Correlation of parameters of hydrothermal processes (temperature, humidity and treatment time) with changes in aesthetic (wood color), chemical, histochemical, and histological properties of wood. Determining the correlation, theoretical and practical modeling of color changes, implementation, optimization and development of procedures.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Conduct independent research on the dependence of colors, anatomical structure and chemistry of wood substances. 2. Analyze the impact of color change on the duration of the process and changes in wood properties. 3. Set up and model the optimal process of obtaining the desired color for commercial types of wood.		
3. MONITORING AND EVALUATION OF STUDENT WORK			

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☐
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Charrier, B., Charrier, F., Janin, G., Kamdem, D. P., Irmouli, M., Goncalez, J., (2002): Study of industrial boiling process on					
	Gorišek, Ž., Straže, A., Ribič, A. (2000): Numerical evaluation of beechwood discolouration during drying. Drvna Industrija, Vol.					
	Klarić, Miljenko; Pervan, Stjepan; Prekrat, Silvana; Brezović, Mladen; Biošić, Dražen: Oxidative Discolouration of Alder Wood					
	Pervan, Stjepan: Tehnologija obrade drva vodenom parom / Zagreb : Šumarski fakultet, 2009.					
	Pervan, Stjepan; Draščić, Goran; Antonović, Alan: Ekološka problematika nusprodukata hidrotermičkih procesa obrade drva. /					
4.2. Additional literature	Pervan, Stjepan; Prekrat, Silvana; Gorišek, Željko; Straže Aleš: Problematika varijacije boje i primjene parene orahovine					
	Straže, Aleš; Gorišek, Željko; Pervan, Stjepan; Prekrat, Silvana; Antonović Alan: Research on colour variation of steamed					

1. GENERAL DATA			
1.1. Name of the course	Wood composites of fragmented structure	1.6. Course teacher(s)	Prof. Vladimir Jambreković, PhD Assist. Prof. Nikola Španić, PhD
1.2. Name of the module (if applicable)	Wood composite materials	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/vladimir-jambrekovic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/nikola-spanic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	15 + 10 + 10
1.4. No. of the course	43	1.9. ECTS credits	7
1.5. Code of the course	DDT209	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) to introduce students with the important anatomical and technological properties of wood and the possibilities of designing and optimizing wood particles and fibres 2) to perform a detailed analysis of chemical components, to adopt the technology of design and production and to explain their compatibility and interaction on the properties of composite of fragmented structure 3) to give an overview and determination of analytical images of the chemical structure of synthetic resins and list methods for resin modification and reduction of free formaldehyde emissions 4) to list modern methods of analysis of the distribution of synthetic resins on wood fibres and wood particles (chips) and methods of optimizing the resin application		

	5) to show the influence of technological factors on panel properties, to point out the most important factors and list the models of technological parameters optimization. 6) to present modern methods of boards testing, present test results, point out their dependencies and train students to improve production processes in order to optimize the boards properties
2.2. Course contents (syllabus)	Influence of chemical modification of wood fibres on fibreboards properties. Applicability of recycled wood and annual plants in the production of composite materials of fragmented structure. Dependence of anatomical structure of wood and wood particles adhesion. Wood particles size as a factor of particleboard quality. Influence of the molar ratio of urea and formaldehyde in UF resins on the properties of wood composites. Impact of UF resin modification with melamine on dimensional stability and formaldehyde emission. Chemical composition of paraffin and type of emulsifier as factors reducing the hydrophobic properties of MDF boards. Technological factors of formaldehyde emission. Influence of chemical additives on the reduction of formaldehyde emissions. Modification of synthetic resins with natural resins based on tannins, lignosulfonates and liquefied wood and its impact on the properties of composites. Analysis of the distribution of urea-formaldehyde resin on MDF fibres by laser microscopy. Photoelectron spectroscopic determination of urea-formaldehyde resin on MDF fibres. XPS diagnostics. Integral model of MDF board pressing. Optimizing the properties of MDF boards by pre-pressing. Influence of technological parameters on strand (particles) orientation of OSB boards. Analysis of strands orientation in OSB boards using fast FT method. Chemical changes of components during hot pressing of particleboards. OSB panels dimensional stability improvement by subsequent heat treatment. Analysis of gamma ray density profile images. Variations in strength and fatigue of OSB, particleboards and MDF. Analysis of mechanical properties of OSB and MDF boards using FEM method. Analytical and experimental studies of shear and compressive stresses of MDF boards obtained using Iosipescu device. Investigation of rheological properties of particleboards, MDF and OSB. VOC emissions of wood composites from recycled wood. Influence of hydrolytic and thermal decomposition of amino resins on formaldehyde emission in wood panels use. Emission analysis of chemical components during combustion of wood composites of fragmented structure.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) to select wood raw material and to design and optimize the characteristics of wood particles (chips) and wood fibres 2) to explain the design, production, compatibility and interaction of chemical components and to apply them in the production of wood composites of fragmented structure

	3) to determine analytical images of the chemical structure of synthetic resins, implement methods of resin modification and to produce wood composite of fragmented structure with reduced free formaldehyde emission 4) to analyse the distribution of synthetic resins on wood fibres and wood particles (chips) and adopt methods for optimizing resin application 5) to analyse and explain the influence of technological factors on panels properties and to design models for technological parameters optimization 6) to apply modern methods for testing the properties of composites, to explain the test results, determine their dependencies and optimize their properties					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☐
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Sandberg, D., Kitek Kuzman, M., Gaff M. 2018. EWPs: Wood as an Engineering and Architectural Material. Czech University of					
	Thoemen, H., Irle, M., Šernek, M. 2010: Wood-based Panels - An Introduction for Specialists. Brunel University Press.					
	Jambreković, V. 2004: Drvne ploče i emisija formaldehida. Šumarski fakultet, Zagreb.					
	Pizzi, A., Mittal, K. L. 2003: Handbook of Adhesive Technology, Second edition, Revised and Expanded. Marcel Dekker, Inc.,					
4.2. Additional literature	Selected scientific papers					

1. GENERAL DATA			
1.1. Name of the course	Structural analysis of composite plywood	1.6. Course teacher(s)	Assoc.Prof. Jaroslav Kljak, PhD Prof. Mladen Brezović, PhD
1.2. Name of the module (if applicable)	Composite wood materials	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/jaroslav-kljak/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	15+10+10
1.4. No. of the course	44	1.9. ECTS credits	7
1.5. Code of the course	DDT210	1.10. Language(s)	Croatian x English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	On the lecture, a specific knowledge of interaction between structural materials of composite plywood, are presented, in the aim to obtain an exact analyse and optimisation of multilayer heterogeneous structure. The outermost aim of lecture is developing a new type of composite plywood, with optimal structure and construction, based on the experimental and theoretic results of scientific research.		
2.2. Course contents (syllabus)	Analysis of composite plywood properties due to different type of its structure. Specification of synthetic polymer materials, woods, and metals. Static and dynamic characterisation of structural materials under different type of loads. Characterisation of effective elastic modulus of an integrate materials of composite plywood, and analyse of new elastic constants. Analysis of bending properties, normal stress, panel buckling, materials fatigue, dynamic stress. Analysis of rupture nature and, optimisation of sandwich structure under the predefined load. Weight minimisation of sandwich structured composite. Influence of mechanical properties of outer layers on the relevant core properties. Interlaminar shear stress of composite plywood with implemented plies of synthetic fiber composite. The effect of thermal stress on composite plywood. Hygroscope properties of heterogeneous structures. Variability of acoustic properties influenced by the structural construction and materials selection.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	Student will be able to: 1. Calculate an influence of structural materials on static properties of composite plywood. 2. Analyse the new elastic constants. 3. Analyse the nature of rupture.		

	4. Optimise a sandwich structure under predefined load. 5. Determine a minimal weight of sandwich structured composite. 6. Calculate the influence of mechanical properties of outer layers on the relevant core properties. 7. Interpret a thermal, hygroscopic, and acoustic property of composite plywood.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	+	Research	☐	Oral exam	+
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	+	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	+	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Brezović, M., Jambreković, V., Kljak, J. (2002): Utjecaj karbonskih vlakana na neka relevantna svojstva furnirskih ploča. Drvna
	Kljak, J., Brezović, M., Jambreković, V., (2003): Analiza interakcije strukturnih materijala kompozoitnoga uslojenog drva
	Kljak, J.; Brezović, M.; (2007): Influence of plywood structure on sandwich panel properties: Variability of veneer thickness
	Kljak, J.; Brezović, M.; (2007): Relationship between bending and tensile stress distribution in veneer plywood. Forest
	Kljak, J.; Brezović, M.; Antonović, A. (2009): Influence of plywood grain direction on sandwich panel bending properties.
	Brezovic, M.; Kljak, J.; Pervan, S.; Antonovic, A. (2010): Influence of synthetic fibers angle orientation on bending properties
4.2. Additional literature	Barbero, Ever J. (2007): Finite element analysis of composite materials. CRC Press, Taylor & Francis Group.
	Tom, Bitzer. (1997): Honeycomb Technology. Materials, design, manufacturing, applications and testing. Champman & Hall.
	Herakovich, C.T. (1998): Mechanics of Fibrous Composites. New York: John Wiley & Sons, Inc.
	Zenkert, D. (1997): The Handbook of Sandwich Construction. West Midlands: Engineering Materials Advisory Services Ltd.

1. GENERAL DATA			
1.1. Name of the course	Construction theory	1.6. Course teacher(s)	Prof. emeritus Ivica Grbac, PhD Assoc. Prof. Ivica Župčić, PhD
1.2. Name of the module (if applicable)	Development of wood constructions	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ivica-grbac/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ivica-zupcic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	20 + 5 + 10
1.4. No. of the course	45	1.9. ECTS credits	7
1.5. Code of the course	DDT211	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	Introduction to the latest achievements in the field of construction and research of structural joints. Application of structural joints in wood products. Develop the knowledge necessary to evaluate and conduct research on structural joints and integrate this knowledge into structural models. Develop critical thinking skills in the field of construction and develop skills in conducting and analyzing experiments independently.		
2.2. Course contents (syllabus)	Basic concepts of the theory of construction of wood products, theory and technology of furniture construction, furniture construction process, theory of construction of elements of wood systems and systems in general, numerical analysis and methods, methods of theoretical and experimental analysis of wood structures, methods of wood construction design. Evaluation of structural joints and application of CAD programs in rationalization and production. Construction solutions depending on the physical and mechanical properties of solid wood and wood panels. Functionality, safety and comfort of furniture.		

2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Develop an innovative structural solution in the construction of furniture and furniture parts based on scientific methods and laboratory tests. 2. Analyze the proposed construction of wood products and propose a more rational solution based on the budget, the use of new materials, technology and CAD systems for construction. 3. Evaluate and compare numerical analyzes of structural solutions and apply scientific methods in the design and laboratory testing of structural joints. 4. To propose, design and conduct independent scientific - research work on the topic of construction of wood products.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☒		

4. LITERATURE LIST

4.1. Obligatory literature	Domljan, D.; Grbac, I.; Jirouš Rajković, V.; Vlaović, Z.; Živković, V.; Župčić, I. 2015: Kvaliteta i tehnički opisi proizvoda od drva,
	Grbac, I., Ivelić, Ž. 2005: Ojastučeni namještaj, Sveučilišni udžbenik, Sveučilište u Zagrebu, Šumarski fakultet Zagreb.
	Nutsch, W. 2012: Handbuch der Konstruktion Innenausbau, Verlags-Anstalt, Deutsche.
	Grbac, I. 2006: Krevet i zdravlje, Sveučilišni udžbenik, Sveučilište u Zagrebu, Šumarski fakultet Zagreb.
	Gavronski, T. 2000: Multiobjective optimisation of a skeletion furniture construction. Roczniki akademii rolniczej w Poznaniu, Poznan
	Smardzewski, J. 2015: Furniture Design. Springer International Publishing.
4.2. Additional literature	Župčić, I.; Žulj, I.; Kamerman, I.; Grbac, I.; Vlaović, Z. 2021: Research into corner L separable assemblies in storage gurniture.
	Župčić, I., 2010: Čimbenici koji utječu na spajanje bukovih tokarenih elemenata tehnikom zavarivanja, disertacija. Sveučilište u
	Smardzewski, J.; Klos, R., 2011: Modeling of joint substitutive rigidity of board elements, Forestry and Wood Technology 73:
	Žulj, I.; Župčić, I.; Grbac, I.; Ponjan, D. 2016: Application of welded joints in furniture manufacturing, 27th International

Župčić, I.; Žulj, I.; Grbac, I.; Radmanović, I.; 2021: Dependence of dowel joint strength on welding temperature in rotary
Pavković, N: Objektno orijentirani pristup modeliranju procesa konstruiranja, disertacija; Zagreb: Fakultet strojarstva i
Tkalec, S.; Prekrat, S.; Dalbelo Bašić, B.; Jalžabetić, D. 1999: Čvrstoća spojeva izvedenih klinastim zupcima pri dužinskom
Dziegielewski, S.; Smardzewski, J. 1995: Projekt i konstrukcija. Panstwowe wydawnictwo rolnicze i lesne, Poznan.

1. GENERAL DATA			
1.1. Name of the course	Ergonomic research	1.6. Course teacher(s)	Prof. emeritus Ivica Grbac, PhD Assoc. Prof. Ivica Župčić, PhD
1.2. Name of the module (if applicable)	Development of wood constructions	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ivica-grbac/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ivica-zupcic/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	15 + 10 + 10
1.4. No. of the course	46	1.9. ECTS credits	7
1.5. Code of the course	DDT212	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	Introduction to the latest achievements in the field of ergonomics, anthropometry and biomechanics. Develop the knowledge needed to conduct research on ergonomics and integrate this knowledge into ergonomic furniture. Think critically in the field of ergonomics, and develop skills in independently setting up, conducting and analyzing experiments		
2.2. Course contents (syllabus)	Development of ergonomics, theory of development and application of ergonomics. Introduction to the sistem: human - furniture - environment system. Biomechanics, theory of development and application of biomechanics. Theory of the development of anthropology. Time and motion research. Anthropometry. Theory and application of static (biological), dynamic and psychophysiological anthropometry. Measurement methods in anthropometry. Biomechanical theory of human motion. Biomechanical models and analysis of human movements. Application of biomechanics. Biomechanics of the spine. Structure and function of the spine. Ergonomic research of furniture. Research on the influence of furniture design on the correct position of the human body at work and at rest. Analysis of the movement and position of individual body parts in relation to the use of individual		

	functional groups of furniture. Investigation of the influence of mechanical, biological and psychophysiological characteristics of man. Ergonomic analyzes. Application of ergonomic models in the design of functional groups of furniture. Ergonomic design parameters and research and application of economy in seating and reclining furniture. Research and application of seating ergonomics. The relationship between the bed system and the body of the sleeper. Furniture for work and rest. Ergonomic design parameters of school, office, dining room, kitchen furniture. HRN EN and ISO standards. Application of computer programs for determining optimal ergonomic parameters in the design of a functional group of furniture. Research by digital 3D anthropometric motion analysis. Research and visual design and modeling of furniture elements and people using 3D graphics programs. 3D visualization and examples of spatial movement of subjects when using furniture.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Develop innovative furniture solutions for work and rest (sitting and lying) with the application of ergonomics, anthropometry and biomechanics in the function of human health. 2. Analyze the position of the human body at work and rest and propose ergonomic solutions tailored to the user with the use of new and innovative materials. 3. Evaluate, research and model furniture and user elements using 3D graphics programs. 4. To propose, design and conduct independent scientific - research work on the topic of furniture ergonomics.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes						
	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☒		

4. LITERATURE LIST

4.1. Obligatory literature	Domljan, D.; Grbac, I.; Jirouš Rajković, V.; Vlaović, Z.; Živković, V.; Župčić, I. 2015: Kvaliteta i tehnički opisi proizvoda od drva,
	Grbac, I., Ivelić, Ž. 2005: Ojastučeni namještaj, Sveučilišni udžbenik, Sveučilište u Zagrebu, Šumarski fakultet Zagreb.
	Muftić, O., Veljović, F., Jurčević-Lučić, T., Miličić, D. 2001: Osnovi ergonomije, Univerzitet u Sarajevu, Mašinski fakultet

	Grbac, I. 2006: Krevet i zdravlje, Sveučilišni udžbenik, Sveučilište u Zagrebu, Šumarski fakultet Zagreb.
	Rana, N.K.; Shah, A.A.; Iqbal, R.; Khanzode, V. 2022: Technology enabled ergonomic design. Springer Singapore.
	Grbac, I. 2003: Zdrav život – zdravo stanovanje, Spektar media Zagreb
4.2. Additional literature	Smardzewski, J. 2015: Ergonomics of Furniture. Springer International Publishing Switzerland.
	Vlaović, Z. 2009: Činitelji udobnosti uredskih stolica, disertacija, Sveučilište u Zagrebu, Šumarski fakultet, Zagreb
	Domljan, D. 2011: Oblikovanje školskog namještaja kao preduvjet očuvanja zdravlja učenika, disertacija, Sveučilište u
	Panero, J.; Zelnik, M. 2009: Antropološke mere i interijer. Građevinska knjiga a.d.
	Alibegović, A.; Mačak Hadžiomerović, A.; Pašalić, A.; Domljan, D. 2020: School furniture ergonomics in prevention of pupils'
	Vlaović, Z.; Domljan, D.; Župčić, I.; Grbac, I. 2016: Evaluation of office chair comfort. Drvna industrija, 67 (2): 171-176.
	Vlaović, Z.; Domljan, D.; Župčić, I.; Grbac, I. 2012: Thermal Comfort While Sitting on Office Chairs - Subjective Evaluations.
	Muftić O. 2006: O nekim antropodinamičkim idejama u biomehanici i ergonomiji. Conference Proceedings, Ergonomija.

1. GENERAL DATA			
1.1. Name of the course	Industrial production theory	1.6. Course teacher(s)	prof. Denis Jelačić, PhD. assis. prof. Andreja Pirc Barčić, PhD.
1.2. Name of the module (if applicable)	Production theory	1.7. Link(s) to CV of teacher(s)	Denis Jelačić | Faculty of Forestry and Wood Technology (unizg.hr) Andreja Pirc Barčić | Faculty of Forestry and Wood Technology (unizg.hr)
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	25 + 0 + 10
1.4. No. of the course	47	1.9. ECTS credits	7
1.5. Code of the course	DDT 213	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	To enable the student for projecting, structuring and efficiency evaluating the production systems and processes in wood processing and furniture manufacturing.		
2.2. Course contents (syllabus)	Production theory as a scientific and applied discipline. Production as a technological, organizational, economical and social system. Production systems basic theory. Production as a dynamic process in a real time. Production as a group of porcesses. Production systems and processes projecting. Products and structure of the production. Production volume. Characteristic models in industrial wood processing. Conventional and un-conventional technological processes in industrial wood processing. Industrial production technology as a basic determinant of production program. Structural characteristics of production technology. Production technology as a complex expression of a functional production. Mathematical modelling of industrial processes. Production capacities and necessary material resources for efficient production. Production function. Production resources. Types, meaning and quantities of production factors. Factors combination for the best effects. Supstitutions of the factors. Types of production functions. Matematical models for determination of production functions. Total, average and limit production. Material transformation curves to higher value. Optimal combination of production factors investments.		

	Basic indexes of production efficiency. Measures and measurement of production efficiency. Productivity. Measurement of production and technological processes productivity. Measurement of economical values of production and technological processes. Possibilities and optimisation of production and technological processes. Organization theory of production and production processes.					
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. To project the production system and production processes. 2. To determine the production program. 3. To determine required production and business resources. 4. To determine production functions. 5. To determine indexes for production efficiency.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☒	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Majdančić, N.: IZGRADNJA INFORMACIJSKIH SUSTAVA PROIZVODNIH PODUZEĆA, Strojarski fakultet, Slavonski Brod, 2004.					
	Schroeder, R.G.: UPRAVLJANJE PROIZVODNJOM, MATE, Zagreb, 1999.					
	Majcen, Ž.: TEORIJA PROIZVODNJE, Informator, Zagreb, 1994.					
4.2. Additional literature	Salvatore, D.: Ekonomija za poduzetnike, Mate d.o.o., Zagreb, 2005.					
	Osmanagić Bedenik, N.: Operativno planiranje, Školska knjiga, Zagreb, 2002.					
	Meredith, J.R.: THE MANAGEMENT OF OPERATIONS, John Wiley and sons, inc., USA, 1992.					

1. GENERAL DATA			
1.1. Name of the course	APPLICATION OF INFORMATION SYSTEMS IN BUSINESS AND PRODUCTION PROCESSES	1.6. Course teacher(s)	Assist. Prof. Ivana Perić, PhD Assist. Prof. Krešimir Greger, PhD Assist. Prof. Kristina Klarić, PhD
1.2. Name of the module (if applicable)	THEORY OF PRODUCTION	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/ivana-peric/ https://www.sumfak.unizg.hr/en/about/general-information/staff/kresimir-greger/ https://www.sumfak.unizg.hr/en/about/general-information/staff/kristina-klaric/
1.3. Status of the course	course of the modul	1.8. Structure of teaching (number of hours: L + E + S)	25+0+10
1.4. No. of the course	48	1.9. ECTS credits	7
1.5. Code of the course	DDT 214	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1. The aim of the course is to acquaint students with the concept of business information system. 2. Achieve students to learn and understand the concepts, principles and architecture of information systems. 3. To train the student to work in ERP software.		
2.2. Course contents (syllabus)	Introduction to the course. Defining the concept of the system, environment and type of system. Application of systems theory: systems approach, systems analysis, modeling. Enterprise as a business system. Definition and concept of information system (MRP, MPR II, BPM, ERP). Information system architecture. Methodology for selecting the appropriate information system. Business process re-engineering. Implementation of information systems. Database. Database design and management. Preparation of software support projects and formalization of business requirements (work in the software system). Analysis of acquired knowledge and creation of research for scientific work.		
2.3. Expected learning outcomes at the level of	1. Synthesis of content and individual topics from the subject for writing reports and seminar papers.		

the course (4 to 7 learning outcomes)	2. Critical discussion of scientific papers read with fellow students and teachers 3. Explain and describe the concepts of production planning and management system 4. Handle and operate in the ERP software. 5. Measure the performance of ERP implementation					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☐
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Majdandžić, N.: Izgradanja informacijskih sustava proizvodnih poduzeća. Sveučilište u Osijeku, Strojarski fakultet, Slavonski					
	Panian, Ž., Ćurko, K.: Poslovni informacijski sustavi, Element, Zagreb, 2010.					
	Grladinović, T.: Upravljanje proizvodnim sustavima u preradi drva i proizvodnji namještaja, Šumarski fakultet, Sveučilište u					
	Champy, J.; Hammer, M.: Reinženjering tvrtke, Poslovna knjižara UM, 2005.					
4.2. Additional literature	Šimović, V.: Uvod u informacijske sustave., Sveučilište u Zagrebu, Učiteljski fakultet, Zagreb, 2009.					
	Schimitzek, P.: Industry-Specific ERP Systems: Integrating Information and Business Processes in the Enterprise, CRC Press,					
	Monk, E.; Wagner, B.: Concepts in Enterprise Resource Planning, Second Edition, 2010.					
	„+ Selected scientific articles"					

SECOND CREDIT GROUP – COMPULSORY COURSES

1. GENERAL DATA			
1.1. Name of the course	REMOTE SENSING AND GIS IN FORESTRY	1.6. Course teacher(s)	Prof. Renata Pernar, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/renata-pernar-rodj-fintic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	10 + 10 + 4
1.4. No. of the course	49	1.9. ECTS credits	7
1.5. Code of the course	DS3	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to get acquainted with the latest achievements in the field of remote sensing in our country and in the world, theoretical foundations of remote sensing, types of recording systems and recording methods, and possibilities of aerial and satellite imagery in forestry, nature protection and environmental protection. Students are also introduced to ways of establishing geographic information systems, as aids for storing, processing and analyzing data, and maintaining and connecting them with other disciplines.		
2.2. Course contents (syllabus)	Technological and physical fundamentals of remote sensing. Electromagnetic radiation in remote sensing. Remission and reflection. Characteristics of reflection from the Earth's objects and atmosphere (vegetation, water, soil). Registering electromagnetic radiation (surveying). Surveying tools. Types of sensors. Photographic and non-photographic procedures in remote sensing. Types of remote sensing from space. Satellite images, radargrams and thermograms. Resolutions of satellite images. Methods of interpretation in RS. Applications of remote sensing in forestry, nature protection and environment conservation. Remote sensing and GIS. Development of GIS. Types and characteristics of computer technology and programme support necessary for GIS. Databases. Methods and conditions for system design. The use of global positioning systems (GPS) in graphic database maintenance. Integrating RS products into GIS. Vector and raster GIS. Data conversion. Digital terrain model (DTM) – types, construction methods and application. Analysing data and creating new layers in GIS. Applications of GIS in forestry (examples).		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Highlight the basic principles of remote sensing and their physical and technological basis. 2. Conduct visual, measurement and digital interpretation on aerial photographs. 3. Show the establishment of a database in GIS.		

	4. Apply different data formats to display objects. 5. Implement the association of the attribute database with the geometric data. 6. Compare and describe the analysis of vector and raster data. 7. Explain the application of RS and GIS in forestry.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☒
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Konecny, G. (2002): Geoinformation: Remote Sensing, Photogrammetry and Geographic Information Systems. CRC Press. 280					
	Lillesand T.M., Kiefer R.W. and j. W. Chipman (2004): Remote sensing and image interpretation, Wiley & Sons, 763 str.					
	Weng, Q. (2009): Remote sensing and GIS integration, theories, methods and applications. McGraw-Hill Education. 416 str.					
4.2. Additional literature	Oštir, K. Mulahusić, A. (2014): Daljinska istraživanja. Građevinski fakultet, Univerzitet u Sarajevu, 343 str.					
	Steede-Terry, K. (2000): Integrating GIS and the Global Positioning System. ESRI Press, USA. 150 str.					

1. GENERAL DATA			
1.1. Name of the course	Reproductive physiology of forest trees	1.6. Course teacher(s)	prof. Željko Škvorc, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/zeljko-skvorc/ https://www.sumfak.unizg.hr/en/about/general-information/staff/jozo-franjic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	10+6+8
1.4. No. of the course	50	1.9. ECTS credits	7
1.5. Code of the course	DSU1	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Develop the knowledge necessary to evaluate and conduct research on seed and fruit physiology and to integrate this knowledge into plant functioning models. Develop skills of critical thinking in the field of plant physiology as well as independent design, implementation and analysis of scientific experiments.		
2.2. Course contents (syllabus)	Physiology of fertilization - pollen, fertilization, external factors affecting pollen germination and fertilization, compatibility and incompatibility. Fertilization and growth of fruits and seeds. Flowering control, effect of plant age on flowering, sensitivity of plants to day length, vernalization, biochemical signals involved in flowering. Physiological processes from fertilization to fruit maturation - growth and development of the fruit, correlations. Chemical composition of seeds, seed life, seed viability and vitality, seed dormancy, inhibitors, stratification. Seed germination, biological, physical and chemical factors affecting seed germination.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Explain the physiological processes of forest trees fructification. 2. Analyze and interpret the influence of environmental factors on the physiological processes involved in the reproductive cycle of forest trees with respect to its phases. 3. Design research and experiments related to different phases of the reproductive cycle of forest trees. 4. To correctly interpret the results of scientific research in the field of fructification physiology.		

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Lambers, H., Oliveira, R.S. 2019: Plant Physiological Ecology. Springer International.
	Pallardy S. G., 2008: Physiology of Woody Plants, 3. izd. Elsevier Inc.
	Sever, K. et al. 2013: Koji ekofiziološki čimbenici utječu na reprodukciju šumskoga drveća i da li je ono u prošlosti rađalo sjemenom češće i obilnije? Radovi – Šumar. inst. Jastrebar. 45(2): 175–194.
4.2. Additional literature	Sever, K., 2012: Utjecaj ekofizioloških čimbenika na razvoj rasplodnih organa hrasta lužnjaka (Quercus robur L.). Doktorski rad. Sveučilište u Zagrebu-Šumarski fakultet. Zagreb.
	Peman, J., et al. 2017: Physiological keys for natural and artificial regeneration of Oaks. U:Gil-Pelegrin, E., Peguero-Pina, J.J., Sancho-Knapik (Ed.) Oaks physiological ecology. SprinjerInternational Publishing.
	+ selected scientific articles (a maximum of 10 articles)

1. GENERAL DATA			
1.1. Name of the course	Problems of forest fires	1.6. Course teacher(s)	Prof. Željko Španjol, Ph.D. Prof. Damir Barčić, Ph.D.
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/zeljko-spanjol/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/damir-barcic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	10+8+8
1.4. No. of the course	51	1.9. ECTS credits	7
1.5. Code of the course	DSU7	1.10. Language(s)	Croatian ☒ English ☐

2. COURSE DESCRIPTION	
2.1. Course objectives	Causes of fires in the ecosystem, and processes after the fire regeneration of natural forest stands and artificially raised forest crops. Introduce students to the basic factors that determine the priorities of remediation of fire-affected areas. These are primarily the type of fire, geomorphological conditions, relief, pedological conditions, climate and socio-social and economic factors.
2.2. Course contents (syllabus)	Recognition of synecological features of areas in which fires occur for the area of eumediterranean, sub-Mediterranean and continental high karst (gemorlogical, pedological, relief, climatic and vegetation characteristics of space). Factors for assessing the priority of remediation and restoration of burned areas. Qualitative and quantitative forms of damage (economic value, public benefit value).
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Fuel material ranking. 2. Evaluation of the vulnerability assessment model. 3. Understanding firefighting activities. Analyzing the methods and forms of hazard assessment. 4. Analyzing species suitable for restoration. Evaluation of recovery methods.

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐

evaluation of achieved learning outcomes	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Španjol,Ž., Barčić, D., 2020: Šumski požari. Fakultet šumarstva i drvne tehnologije. Zagreb. (interna skripta)					
	Keely, J.E., Bond, W.J.,Bradstock, R.A., Pausas, J.G., Rundel, P.W. 2012: Fire in Mediterranean Ecosystems. Cambrdge					
4.2. Additional literature	Španjol, Ž., Biljaković, K., Rosavec, R., Dominko, D., Barčić, D., Starešinić, D. (2008): Šumski požari i fizikalni modeli. Šumarski					
	Španjol, Ž., Barčić, D., Rosavec, R., Mandić, A., Vučetić, M (2006): Procjena ugroženosti mediteranskih šuma od požara					
	Vučetić, M, Španjol, Ž. & Barčić, D. 2002: Prirodna obilježja i potencijalna opasnost od šumskih požara., 169-183. Zbornik					
	Španjol, Ž, Barčić, D. (2001): Biološka sanacija šumskih požara u sastojinama crnog bora (Pinus nigra Arnold) . Znanost u					
	Thomas, P.A. McAlpine, R.S. 2010: Fire in the Forest. Cambridge University Press, 225.					

1. GENERAL DATA			
1.1. Name of the course	Wetlands and floodplain forests	1.6. Course teacher(s)	Prof. Igor Anić, PhD Prof. Joso Vukelić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/igor-anic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/joso-vukelic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	10+6+8
1.4. No. of the course	52	1.9. ECTS credits	7
1.5. Code of the course	DSU 10	1.10. Language(s)	Croatian X English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	To train students for: 1. analysis of wetland and flood forest ecosystems: their distribution, genesis, succession, floral composition, site specificity, structure, and morphology, 2. assessment of the impact they are exposed to, 3. proposing management methods in such forests in order to preserve their stability, natural structure, biodiversity and productivity, 4. analysis of examples of methods of revitalization of endangered stands, especially in cases of changes in water regime.		
2.2. Course contents (syllabus)	Basic terms: swamp forest - floodplain forest - lowland forest. Distribution and emergence of wetlands and floodplain forests in Croatia and Europe. Synecological factors: climate, microrelief, water regime, and soil. Ecoindicators of site conditions, their distribution depending on geomorphological, edaphic and hydrological conditions. Natural succession: from abandoned wet meadows over forest edges and pioneer to perennial plant communities. The role of river and water in vegetation development. Tree species of wetlands and floodplains. The role of forests in these areas, their diversity and impact on other natural and artificial ecosystems. Morphology and structure of forest stands, differences and consequences in management in certain European areas, the need to establish certain protected areas and monitoring. Silvicultural practices in wetlands and floodplain forests, especially in altered hydrological conditions. Possibility of various interventions and adaptations to the dynamics and specifics of the role and purpose of forests. Impact of environmental interventions on forests: a case study. Examples of preservation, renaturation and revitalization of wetlands and floodplain forests.		

2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. analyze wetland and floodplain forest ecosystems, their distribution, genesis, succession, floral composition, site, structure, morphology 2. assess the impacts to which they are exposed 3. recommend the management method for an individual forest stand 4. 4. recommend a method of revitalization of the endangered stand, 5. make a silvicultural plan for a particular forest community.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	X
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	X	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Klepac, D. (gl. ur.), 1996: Hrast lužnjak (Quercus robur L.) u Hrvatskoj. Centar za znanstveni rad HAZU u Vinkovcima i Hrvatske					
	Klimo, E., H. Hager, S. Matić, I. Anić, J. Kulhavy (ur.), 2008: Floodplain forests of the temperate zone of Europe. Lesnica prace,					
	Oršanić, M. (gl. ur.), 2020: Ekologija, obnova i zaštita poplavnih šuma Posavine. Sveučilište u Zagrebu, Šumarski fakultet, 368					
	Vukelić, J. (gl. ur), 2005: Poplavne šume u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 455 str.					
	Vukelić, J., 2012: Šumska vegetacija Hrvatske. Sveučilište u Zagrebu, Šumarski fakultet, Državni zavod za zaštitu prirode, 403					
4.2. Additional literature	Klimo, E., H. Hager (ur.), 2001: The floodplain forests in Europe – current situation and perspectives, European Forest					
	Penka, M., M. Vyskot, E. Klimo, F. Vašiček, 1985: Floodplain forest ecosystem. Academia, knjiga I, Praha, 466 s.					
	Penka, M., M. Vyskot, E. Klimo, F. Vašiček, 1985: Floodplain forest ecosystem. Academia, knjiga II, Praha, 629 s.					
	+ selected scientific articles according to the special preferences of each student (maximum 10 articles)					

1. GENERAL DATA			
1.1. Name of the course	SOIL ORGANIC MATTER AND CARBON CYCLE	1.6. Course teacher(s)	Prof. Nikola Pernar, PhD Prof. Darko Bakšić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/nikola-pernar/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/darko-baksic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	8 + 10 + 8
1.4. No. of the course	54	1.9. ECTS credits	7
1.5. Code of the course	DSU13	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to provide students with knowledge about the cycle of matter in the forest ecosystem, primarily through the accumulation, decomposition and transformation of organic matter. Furthermore, the aim is to enable the acquisition of knowledge about the specifics of the nature of soil organic matter. Finally, the aim is to enable the acquisition of knowledge about the sequestration of organic carbon, soil respiration and the climate-regulatory role of soil.		
2.2. Course contents (syllabus)	Forest floor. Model systems of humic substances. Humus forms and types. Soil organic matter function. Quantification of organic matter and its stock in soil. Transformation and distribution of soil organic matter. Biochemistry of humus formation. Organoclay complex and formation of stable aggregates. The role of organic matter in pedogenetic processes. Organic matter dynamics and carbon sequestration. The carbon cycle in different terrestrial ecosystems.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Present the nature of soil organic matter. 2. Describe the manner of decomposition of organic residues and the formation of humus. 3. Explain the differences in organic matter dynamics and carbon sequestration in different forest ecosystems. 4. Present humus forms and the amount of organic carbon in the soil of the forest ecosystem.		

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Pernar, N., 2017: Tlo; nastanak, značajke, gospodarenje. Šumarski fakultet Sveučilišta u Zagrebu, 799 p.
4.2. Additional literature	Berg, B. & C. McClaugherty, 2008: Plant Litter: Decomposition, Humus Formation, Carbon Sequestration. 2nd ed., Springer, 338 p.
	Scheffer, F. & P. Schachtschabel, 2002: Lehrbuch der Bodenkunde. 15. Auflage, neu bearbeitet und erweitert von Blume et al. Spektrum Akademische Verlag Heidelberg, Berlin, 593 p.
	Swift, R. S., 2001: Sequestration of carbon by soil. Soil Sci. 166:858-871.
	Baldock, J. A. & P. N. Nelson, 2000: Soil Organic Matter. In: Sumner, M. E. (Ed.): Handbook of Soil Science, CRC Press, pp. B-25–84.

1. GENERAL DATA			
1.1. Name of the course	Zoogeography and zooecology	1.6. Course teacher(s)	Prof. Josip Margaletić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/department-of-forestry/institute-of-forest-protection-and-wildlife-management/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	5 + 5 + 20
1.4. No. of the course	55	1.9. ECTS credits	7
1.5. Code of the course	DSZ3	1.10. Language(s)	Croatian ☐ English ☒

2. COURSE DESCRIPTION	
2.1. Course objectives	The aim of the course is to get acquainted with the latest knowledge about population dynamics, and horizontal and vertical distribution of animal species, in order to calculate their absolute and relative values as a starting point for timely protection measures. The knowledge acquired should provide students with a link between the importance of behavioral ecology and the conservation of animal species.
2.2. Course contents (syllabus)	Zoogeography and zooecology as sciences. General terms. An organism, a set of organisms and a space. Analytical ecology. Environmental factors. Life form. Ecological niche. Abiotic, trophic and biotic factors. Population ecology. Population size. Methods of population determination. Migration movements. Spatial layout (horizontal and vertical). Microdistribution and macrodistribution of animal populations. Habitus and genetic constitution of the population (birth rate and mortality, age structure). Population dynamics (oscillations and fluctuation types, spatial aspect of population dynamics). Population theories. Synecology. Animal communities (zoocenoses). Types and dynamics of zoocenoses. Biological balance. Organization of animal communities. Food chain. Ecological succession. Periodicity. Ecological energy of individual animal forest groups (physical condition, daily and annual energy content. Circulation of matter and energy in the forest ecosystem. Ecological balance. Changes in the structure of animal populations depending on changes in forest ecosystems. Human impact on animal ecosystems.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Describe the spatial distribution of forest animal species with special reference to the main pests. 2. Design, plan and recommend measures to control the abundance of animal species in commercial forests. 3. List and describe the types of innate and learned behavior. 4. Recognize the mechanisms responsible for innate and learned behavior. 5. Recognize sexual dimorphism and identify intrasexual and intersex selection.

	6. Design a database for monitoring the number and distribution of animals as an aid for storing, processing and analyzing data and linking them with other disciplines aimed at predicting changes in the number of animal populations.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Ausden, M., 2007: Habitat Management for Conservation. Oxford Univerity Press Inc., New York, 411 pp.					
	Manning, A., Dawkins, M.S., 1998: Animal behaviour. Cambridge university press, 450 str.					
	Blasisu, B., Kurths, J., Stone, L., 2007: Complex Population Dynamics: Nonlinear Modeling in Ecology, Epidemiology and Genetics. World Scientific, New Jersey-London-Singapore-Beijing-Shanghai-Hong Kong-Taipei-Chennai, 246 pp.					
	Brown, J. H., 1995: Macroecology. The University of Chicago Press, Chicago, Illinois, USA, 256 pp.					
	Harris, J. D., Brown, P. L., 2009: Wildlife: Destruction, Conservation and Biodiversity. Nova Science Publisher, Inc. New York, 366 pp.					
	Krebs, C. J., 2009: Ecology: The Experimental Analysis of Distribution and Abundance. Pearson, 655 pp.					
4.2. Additional literature	Jacob, J., 2003: The response of small mammal populations to flooding. Mammalian Biology, 68(2): 102-111.					
	Pullin, A. S. Conservation Biology. Cambridge University Press, 2002					
	Alcock J. Animal Behavior: An Evolutionary Approach. Seventh Edition. Sunderland (MA): Sinauer Publishers, 2001.					
	Grubešić, M., Margaletić, J., Glavaš, M., 2007: Dynamika a štruktúra lovu plcha sivého (Glis glis L.) in beech woods and fir woods of Croatia. Folia venatoria, 36-37: 173-181.					
	Grubešić, M., Konjević, D., Severin, K., Hadžiosmanović, M., Tomljanović, K., Mašek, T., Margaletić, J., Slavica, A., 2011: Dresed and undresed weight in naturally bred wild boar (Sus scrofa): The possible influence of crossbreeding. Acta alimentaria. 40(4): 502-508.					

	Margaletić, J., Glavaš, M., Bäumler, W., 2002: The development of mice and voles in an oak forest with a surplus acorns. Anzeiger für Schädlingskunde / Journal of Pest Science, 75(4): 95–98.
	Danchin, E., Giraldeau, L. A., Cezilly, F., 2008: Behavioural Ecology. Oxford Univerity Press Inc., New York, 874 pp.

1. GENERAL DATA			
1.1. Name of the course	NEW KNOWLEDGE ABOUT FARMING OF WILDLIFE	1.6. Course teacher(s)	Prof. Marijan Grubešić, PhD Assist. prof. Kristijan Tomljanović, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/marijan-grubesic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/kristijan-tomljanovic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	10+8+8
1.4. No. of the course	56	1.9. ECTS credits	7
1.5. Code of the course	DSU19	1.10. Language(s)	Croatian ☐ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to acquaint students with new technical and technological achievements that are applied in the intensive breeding of large game in the enclosure. The goals of breeding and technology in accordance with the goal will be presented. Special attention will be paid to the cultivation technologies of individual species and the combined cultivation of several species within one space. The latest knowledge on the results and technologies of breeding in other European countries and in the world will be gathered.		
2.2. Course contents (syllabus)	During the exercises and field classes, the state of farm game breeding in Croatia will be introduced, and through the available literature on achievements in other countries. The candidate acquires knowledge in the field of large game breeding technology in an enclosed space, thus reaching the highest level of knowledge about this method of game breeding so that he can then independently lead intensive game breeding either as a technologist or as an independent breeder - farmer. The student is involved in team work and through analysis and critical discussion of individual segments of the proposed technology related to intensive game breeding, the individual and the group (team) make decisions about the pros and cons of each technological process. The student must independently look for papers that will address a particular topic from game farming. Part of the teaching will take place with the help of thematic audio and video material, and special importance is given to Teran teaching. The knowledge test will be related to general knowledge in the field of game farming, as well as specific and specific tasks.		
2.3. Expected learning outcomes at the level of	1. Introduction to modern achievements of game breeding in game farms		

the course (4 to 7 learning outcomes)	2. Introduction to modern techniques and technology used in game breeding in game farms 3. Organization of professional work, scientific research work in the field of hunting 4. Analysis and data processing, writing professional reports and studies					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☒		
4. LITERATURE LIST						
4.1. Obligatory literature	Bluchel, K. G., 2011: Lovstvo, velika ilustrirana enciklopedija. Znanje, Zagreb, 654 s.					
	Čeveny, J., P. Hell, J. Slamečka, 2004: Enciklopedia Plovnictva. Ottovo nakladatelstvo, Praha, 591 s.					
	Durantel, P., 2007: Enciklopedija lovstva. Leo commerce Rijeka, 608 s.					
	Grupa autora., Velika ilustrovana enciklopedija lovstva 1., 1987: Građevinska knjiga Beograd s 452					
	Grupa autora., Velika ilustrovana enciklopedija lovstva 2., 1987: Građevinska knjiga Beograd s 488.					
4.2. Additional literature	Martini, F., 2010: Wilbret-gewinnung nach Europäischem lebensmittelrecht. Kosmos, 130 s.					
	Pigert, H., W. Uloth, 2000: Der Europäische Mufflon. Monografija, Hamburg/Bremen, 260 s.					
	Schneider, E., 1996: Jagdleksikon. BLV Verlagsgesellschaft mbH, München, Wien, Zürich, 858 s.					
	Silvy, N. J., 2012: The wildlife techniques manual research. 7th edition, the John Hopkins university press, Baltimore, 414 s.					
	Winkelmayer, R., P. Lebersorger, H. F. Zedka, 2008: Wilbret-hygiene, das Buch zur Wilbretverwertung, 164 s.					

1. GENERAL DATA			
1.1. Name of the course	Analysis and asessment of animal population	1.6. Course teacher(s)	Prof. Krešimir Krapinec, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/kresimir-krapinec/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	10+10+6
1.4. No. of the course	57	1.9. ECTS credits	7
1.5. Code of the course	DSU20	1.10. Language(s)	Croatian ☒ English ☒

2. COURSE DESCRIPTION	
2.1. Course objectives	Wildlife abundance and dispersion patterns awake human interest from long time ago. In the past, man-hunter had to study the knowledge in a sense of prey assessment. Recently, population ecology understandings are directed toward better management of free-living wild animals. Thus, objectives of the course are to qualify modern wildlife manager in the field of population ecology. The course is extension of zoological group of graduate study courses at Faculty of Forestry and Wood Technology, University in Zagreb, with strictly direction toward birds and mammals.
2.2. Course contents (syllabus)	Functional structural population elements – behaviour, condition and condition indexes, fertility, mortality – lectures (5 hours) Population dynamic – dispersion (home range, territory), abundance, linkage to landscape structures – lectures (5 hours) Census techniques and habitat evaluation – exercises (5 hours) Assessment of use and dynamic modelling – exercises (5 hours) Seminar paper (7 hours)
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	UNDERSTANDING – to classify population elements and factors influence on population IMPLEMENTATION – measure of population parameters of concrete population, describe its condition and predict it's dynamic in the future CREATE – chose appropriate model of population trend

3. MONITORING AND EVALUATION OF STUDENT WORK						
	Class attendance	☒	Research	☒	Oral exam	☒

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Williams, B.K.; J.D. Nichols; M.J. Conroy, 2001: Analysis and Management of Animal Population – modeling, estimating and decision making. Acadmic Press. 817 pp.					
	Schwerdtfeger, F., 1968: Ökologie der Tiere – Ein Lehr- und Handbuch in drei teilen. Band II: Demökologie – Struktur und Dynamik tierischer Populationen. Verlag Paul Parey, Hamburg und Berlin, 448 pp.					
	Sibly, R. M.; Hone, J., 2002: Population growth rate and its determinants: an overview. Phil. Trans. R. Soc. Lond. B, 357: 1151-1170.					
4.2. Additional literature	Bookhout, T.A.,1996: Research and management techniques for wildlife and habitats. The Wildlife Society Bethesda, Maryland; 740 pp. Maryland; 740 pp.					
	Sutherland, W. J. (ed.), 2006: Ecological census techniques: a handbook. Cambridge University Press, Cambridge, 336 pp					
	Eymann, J.; J. Degreef; Ch. Häuser; J.C. Monje; Y. Samyn; D. VandenSpiegel, 2010: Manual on field recording techniques and protocols for All Taxa Biodiversity Inventories and Monitoring. Volume 8, Part 1, 330 pp.					
	Eymann, J.; J. Degreef; Ch. Häuser; J.C. Monje; Y. Samyn; D. VandenSpiegel, 2010: Manual on field recording techniques and protocols for All Taxa Biodiversity Inventories and Monitoring. Volume 8, Part 2, 331-653 pp.					

1. GENERAL DATA			
1.1. Name of the course	Biological and biotechnological methods in bark beetle management and control	1.6. Course teacher(s)	Prof. Boris Hrašovec, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/boris-hrasovec/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6+8+10
1.4. No. of the course	59	1.9. ECTS credits	7
1.5. Code of the course	DSZ1	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	To educate students in the scope and reach of modern control and management option in bark beetle outbreaks		
2.2. Course contents (syllabus)	Bark beetles as a special forest group of harmful insects are subjected to huge amount of applied research in the field of integrated forest protection. The most dynamic is currently the development of methods for monitoring and controlling their populations using biological and biotechnical methods of protection, but also their combinations. Knowledge of the laws of fluctuations of their populations, intraspecific and interspecific communication by semiochemicals and other sensory "channels", characteristics and ability of their natural enemies, all contribute to the development of new methods of combating and better understanding this important biotic cause of intermittent calamities in temperate and boreal forests. The topics covered include latest knowledge on the role of natural enemies in the dynamics of bark beetle populations with examples of successful and unsuccessful use of natural enemies in the context of biological control methods, analyzes some recent examples from this special area of forest protection. In particular, the use of semiochemicals (pheromones) for the purpose of manipulating bark beetle populations is considered and an overview of the latest ethological findings on European bark beetle species.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. ability to recognize specific scenarios of population outbreak and occurrence of bark beetles in natural and urban habitats 2. theoretical knowledge necessary for the preparation of measures aiming prevention and/or remediation of outbreak foci 3. competencies required for independent analysis and evaluation of necessary or undertaken measures of biological and biotechnical protection against the most well-known species of bark beetles		
3. MONITORING AND EVALUATION OF STUDENT WORK			

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Berryman, A.A., 1986: Forest Insects – Principles and Practice of Population Management. Plenum Press, New York and London, 273 str.					
	Byers, J.A., 2004: Chemical ecology of bark beetles in a complex olfactory landscape. In: Bark and Wood Boring Insects in Living Trees in Europe, a Synthesis (Lieutier F., Day K.R., Battisti A., Gregoire Jean-Claude, Evans H., editors), Kluwer Academic Publishers, 89-134.					
	Kenis, M., B. Wermelinger, J-C. Gregoire, 2004: Research on parasitoids and predators of Scolytidae. In: Bark and Wood Boring Insects in Living Trees in Europe, a Synthesis (Lieutier F., Day K.R., Battisti A., Gregoire Jean-Claude, Evans H., editors), Kluwer Academic Publishers, 237-290.					
	Kirisits, T., 2004: Fungal associates of European bark beetles with special emphasis on the Ophiostomatoid fungi. In: Bark and Wood Boring Insects in Living Trees in Europe, a Synthesis (Lieutier F., Day K.R., Battisti A., Gregoire Jean-Claude, Evans H., editors), Kluwer Academic Publishers, 181-236.					
	Pfeffer, A., 1995: Zentral- und westpaläarktische Borken- und Kernkäfer. Pro Entomologia, Naturhistorische Museum Basel, 310 str.					
	Hajek, A., 2004: Natural enemies - An Introduction to Biological Control. Cambridge University Press, 378 str.					
4.2. Additional literature	Schowalter, T.D., 2000: Insect Ecology – An Ecosystem Approach. Academis Press, USA, 483 str.					
	Wegensteiner, R., 2004: Pathogens in bark beetles. In: Bark and Wood Boring Insects in Living Trees in Europe, a Synthesis (Lieutier F., Day K.R., Battisti A., Gregoire Jean-Claude, Evans H., editors), Kluwer Academic Publishers, 291-313.					
	Quicke, D.L.J., 1997: Parasitic wasps. Chapman & Hall, 470 str.					
	Speight, M.R., M.D. Hunter & A.D. Watt, 1999: Ecology of Insects – Concepts and Applications. Blackwell Science, 350 str.					

1. GENERAL DATA			
1.1. Name of the course	Mycoses of needles and leaves of trees	1.6. Course teacher(s)	prof. Danko Diminić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/department-of-forestry/institute-of-forest-protection-and-wildlife-management/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	7 + 14 + 7
1.4. No. of the course	60	1.9. ECTS credits	7
1.5. Code of the course	DSZ7	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Through the course Mycosis of needles and leaves of trees, doctoral students get acquainted in detail with the causes of diseases of needles and leaves, the symptoms they cause, and damage to trees in forest and urban ecosystems. The aim of this course is to acquaint students with the importance of maintaining and possibly improving the health of forest and urban trees, important not only for the individual but also for the ecosystem as a whole in terms of knowledge of a specific group of pathogens of assimilation organs.		
2.2. Course contents (syllabus)	Fungal organisms occupy an extremely important place among phytopathogenic organisms of forest and urban trees, therefore the symptoms of disease, physiology and biology and systematics of phytopathogenic fungi, pathogenesis and possible preventive and curative protection measures in specific ecological conditions of forest ecosystems and urban areas are discussed in detail. Through lectures, students gain knowledge about this specific group of phytopathogenic fungi, as well as how they adversely affect their host. Through exercises, they gain knowledge and experience in manipulating these organisms, from collecting samples in the field, laboratory analysis and identification of pathogens, to methods of artificial infection (inoculation) of host plants with phytopathogenic fungi of needles and leaves. Through seminars, they independently gather information and gain detailed knowledge about the research of current mycoses of needles and leaves of forest and urban trees in the world. The course also analyzes the negative impact of humans and various biotic and abiotic factors on the predisposition of trees and / or the impact on infection and the development of needle and leaf diseases.		
2.3. Expected learning outcomes at the level of	1. Explain the role of fungal pathogens of needles and tree leaves for infected trees in urban areas and forest ecosystems. 2. Compare fungal diseases with non-infectious or non-parasitic pathogens (abiotic factors, harmful insect species).		

the course (4 to 7 learning outcomes)	3. Analyze the most important and current diseases of needles and tree leaves in forest and urban ecosystems. 4. Analyze the pathogens of needles and leaves of trees according to the symptoms of the disease and virulence. 5. Explain the origin and course of needle and leaf disease in different tree species. 6. Analyze possible preventive and curative measures to protect trees from pathogens of needles and leaves.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Glavaš, M., 1999: Fungal diseases of forest trees. University of Zagreb, Faculty of Forestry, 281 p.
	Butin, H., 1995: Tree Diseases and Disorders. Oxford University Press, Oxford, 252 str.
	Diminić, D., 2013-2021: Important and current (new) diseases of needles and leaves of trees and shrubs (lecture presentations in PDF format).
	Strouts, R.G., T.G. Winter, 1994: Diagnosis of ill-health in trees. HMSO, London, 307 str.
4.2. Additional literature	Glavaš, M., D. Diminić, 2011: Forest tree diseases. In: Matić, S. (ed.): Forests of the Croatian Mediterranean. Academy of Forestry Sciences, Zagreb, 533-555.
	Diminić, D., 2005: Mycoses of poplar and willow bark and leaves. In: Vukelić, J. (ed.) 2005: Floodplain forests in Croatia. Academy of Forestry Sciences, Zagreb, 390–397.
	Sadiković, D., B. Piškur, I. Barnes, T. Hauptman, D. Diminić, M. J. Wingfield, D. Jurc, 2019: Genetic diversity of the pine pathogen Lecanosticta acicola in Slovenia and Croatia. Plant Pathology 68(6): 1120-1131.

1. GENERAL DATA			
1.1. Name of the course	Periodical forest inventories	1.6. Course teacher(s)	Prof. Mario Božić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/mario-bozic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6+12+6
1.4. No. of the course	61	1.9. ECTS credits	7
1.5. Code of the course	DSZ11	1.10. Language(s)	Croatian ☒ English ☐

2. COURSE DESCRIPTION	
2.1. Course objectives	Introducing students with organization methods, data collection and interpretation of the results obtained with forest inventarization on tree, stand and forest area level. To qualify students for independant database searching related to forest inventory, display and analize collected dana (on tree, stand and state level). Training of experts for periodical forest inventories (revision inventories or renewal of management plans, national forest inventories).
2.2. Course contents (syllabus)	Within the course the emphasis will be put on studiyng significance and methods of periodical measurements of trees and stands or broader forest area respectively. Special emphasis will be put on sampling and porblems emerging during measurement. Comparison will be made between results obtained through periodical inventories in relation to changing distribution of tree number within diameter classes as well as diameter of average tree and species ratio. Furthermore, in acordance with preferences of particular candidate specific topic wil be selected for studies and research (specific problem, tree species etc.) which can be in function of dissertation topic.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Explanation of errors that appear during repetitive measurement of tree breast height diameters during control or periodical measurement. 2. Explanation of departure and inconsistency in repeated tree height measurements during control or periodical measurement.

	3. Analisys of measurement errors on tree level on the ability to implement data from periodical measurement for increment modelling 4. Explaining influence of measurement plot centar departure in relation to past measurements on plot and stand level. 5. Analisys of complexity related to data calculation gathered in periodical measurement on circular plots.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Božić, M., Đureta, F., Goršić, E., Vedriš, M., 2020: Utjecaj mjeritelja te pogrešaka pri izmjeri na izmjereni promjer stabla.					
	Čavlović, J., 2017: Nacionalna inventura šuma Republike Hrvatske – Priručnik za provedbu druge inventure šuma. Zagreb.					
	Čavlović, J., Božić, M., 2008. Nacionalna inventura šuma u Hrvatskoj – metode terenskog prikupljanja podataka. Zagreb.					
	Božić, M., 2000: Kolika je stvarna zaliha jele u našim šumama? Šum. list 124(3-4): 185-195.					
	Čavlović, J., Božić, M., Galić, Ž., 2001: Varijabilnost i prostorna raspodjela elemenata strukture i etata na razini sastojine pri					
4.2. Additional literature	Van Laar, A., Akça, A., 2007: Forest Mensuration. Springer, 383 str.					
	Gartner, Dave; Reams, Gregory A. 2001. A comparison of several techniques for estimating the average volume per acre for					
	+ selected scientific articles according to the special preferences of each student (maximum 10 articles)					

1. GENERAL DATA			
1.1. Name of the course	Principles and methods of plant taxonomy	1.6. Course teacher(s)	prof. Željko Škvorc, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/zeljko-skvorc/ https://www.sumfak.unizg.hr/en/about/general-information/staff/jozo-franjic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6+8+10
1.4. No. of the course	62	1.9. ECTS credits	7
1.5. Code of the course	DSZ13	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	Develop the knowledge necessary for independent evaluation and conduct of research in plant taxonomy. Get acquainted with the latest methods of collecting and processing taxonomic data. Develop skills of critical thinking in the field of plant taxonomy as well as independent design, implementation and analysis of scientific experiments.		
2.2. Course contents (syllabus)	Taxonomy - relationship and position towards other scientific disciplines, basic taxonomic concepts. Nomenclature, typification, the problem of understanding taxon width. Family, genus, species, taxa lower than species. Speciation processes, apomixis, hybridization, introgression, polyploidy. Plant identification, production and use of keys, floristic manuals. Significance of herbarium collections. Methods of obtaining and processing taxonomic data - traditional taxonomy, biochemical taxonomy, numerical taxonomy, cladistics, molecular taxonomy. Statistical processing of taxonomic data from different sources. Software tools for data processing. Field collection of materials for taxonomic processing. Examples of processing of individual taxonomic groups by different methods.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Analyze modern scientific knowledge in the field of plant taxonomy and nomenclature. 2. Present the latest methods of collecting and processing taxonomic data. 3. Independently design research in the field of plant taxonomy with the selection of appropriate methods for collecting and processing taxonomic data. 4. Correctly interpret the results of scientific research in the field of plant taxonomy.		
3. MONITORING AND EVALUATION OF STUDENT WORK			

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Nikolić T., 2013: Sistematska botanika - Raznolikost i evolucija biljnog svijeta. Alfa d.d., Zagreb, 1 - 882.
	Judd, W. S., C. S. Campbell, E. A. Kellogg, P. F. Stevens, M.J. Donoghue 2015: Plant Systematics. A Phylogenetic Approach. Sinauer Associates. Sunderland
	Franjić, J., Ž. Škvorc, 2010: Šumsko drveće i grmlje Hrvatske. Sveučilište u Zagrebu – Šumarski fakultet, 432 str. Zagreb
	Franjić, J., Ž. Škvorc, 2014: Šumsko zeljasto bilje Hrvatske. Sveučilište u Zagrebu – Šumarski fakultet, 626 str. Zagreb
4.2. Additional literature	Besse, P. 2021: Molecular Plant Taxonomy. Methods and Protocols. Springer Verlag.
	Nikolić, T., 1996: Herbarijski priručnik, 1-167. Zagreb.
	Stuessy, T. F. 2009: Plant taxonomy - The systematic evaluation of comparative data. Columbia University Press, New York
	Singh, G. 2016: Plant Systematics, 3rd edition: An Integrated Approach. CRC Press.
	Winston, J.E. 2000: Describing Species, Practical Taxonomic Procedure for Biologist. Columbia University Press, New York
	+ selected scientific articles (up to 10 articles)

1. GENERAL DATA			
1.1. Name of the course	Components of forest management planning of forests with special assignment	1.6. Course teacher(s)	Prof. Jura Čavlović, PhD Assoc. Prof. Krunoslav Teslak, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/jura-cavlovic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6 + 12 + 6
1.4. No. of the course	63	1.9. ECTS credits	7
1.5. Code of the course	DSZ15	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) to provide review for knowledge renewing and acquisition about types, characteristics, purpose and functions of forest with special assignment, 2) to enable and train students for prescribing of an appropriate management approaches and guidelines to forest and forest users within several type of special purpose forest, 3) to enable and guide students for study and research of specific problems in special purpose forest management planning.		
2.2. Course contents (syllabus)	This subject takes up with forests which as specific object (special assignment and forest functions, management approach), have certain restrictions and specific management. Consequently, control and regulation of that forest objects has its specifics, requests and restrictions. This relates on forests with social, esthetic and ecological assignments (Mediterranean forests, national parks, nature parks, park forest), small-scale private forests, forests with intensive wildlife management and other forests under special management regime. Contents of the subject pertain to study and research of specific elements of management planning in actual examples of that forests: determination of functions, aims and goals in Mediterranean forest management, valuation of esthetic function and function for tourism of Mediterranean forests, spatial forest regulation on the Karst, forest management plans for national parks, zone defining and spatial arrangement of national park forests, chose of stand and management forms in national parks and nature parks in consideration of main tree species, planning of stand (part of stand) regeneration and tending in national parks, nature parks and park forests, stand structure and management		

	forms of small-scale private forests, structure of owners and estate in small-scale forests in Croatia and other countries, management models of small-scale forests, management plans of small-scale forests.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Describe and classify types of special purpose forests, 2. Describe relations between characteristics and functions of special purpose forests, and requirements and demands of forest users, 3. To use of existing management plans for special purposer forest objects in analyses of actual state and trends of forest changes and demands for forest functions, 4. To project guidelines and activities for future management periods for actual/concrete forest object, 5. Sinthesize of assigned and studied themes in preparing of seminar papers, 6. Discuss critically specific issues of special purpose forest management planning reviewed and studied in scientific articles.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Bradley, G. A., 1995: Urban Forest Landscapes: Integrating Multidisciplinary Perspectives. University of Washington Press, 224 str.
	Božić, M., Čavlović, J., Teslak, K., Goršić, E. & M. Ančić, 2011: Istraživanje i izrada modela uređivanja i izmjere šuma u šumama šumoposjednika. Završno izvješće projekta, Šumarski fakultet, Zagreb, str. 188.
	Čavlović, J. 2004. Unapređenje stanja i gospodarenja privatnim šumama na području Zagrebačke županije. Znanstveni projekt. Šumarski fakultet Zagreb, 126 str.
	Čavlović, J., 2013: Osnove uređivanja šuma. Sveučilište u Zagrebu, Šumarski fakultet, 322 pp.
	Klepac, D., & Š. Meštrović, 1981: Upotreba drveća i grmlja u uređivanju čovjekova okoliša. Šumarski list 1-2, 35-.

	Meštrović, Š., 1987: Uređivanje šuma s posebnom namjenom. Glasnik za šumske pokuse pos. Izd. 3, 137-150.
	Miller, R.W., 1998: Urban forestry: planning and managing urban greenspaces. Prentice Hall, str.404.
4.2. Additional literature	Božić, M., Čavlović, J., Teslak, K., 2006: Research of criteria for detachment of protective stands - forest administration Gospic case study. Glasnik za šumske pokuse, (Posebno izdanje 5): 455-466
	Simončić, T., Bončina, A., Rosset, C., Binder, F., De Meo, I., Čavlović, J., Gal, J., Matijašić, D., Schneider, J., Singer, F., 2013. Importance of priority areas for multi-objective forest planning: a Central European perspective. International Forestry Review, 15(4): 509-523.
	Teslak K., Žunić M., Beljan K., Čavlović J., 2018: Status and chalanges of small-scale private forest management in actual ecological and social circumstances – Croatia case study. Šumarski list, 142(9-1): 459-471.
	Beljan K., Čavlović J., Ištvanić, J., Dolinar D., Lepoglavec K., 2020: Investment Potential of Private Forests in Croatia. Small-Scale Forestry, 19(1): 19-38.
	Anadabaka, M., Teslak, K., Ficko, A., 2021: Private forest owners' sense of landownership: Motives, influential factors and landscape context. Landscape and Urban Planning, Article Number 104200, DOI: 10.1016/j.lurbplan.2021.104200
	+ free choosed scientific articles (up to 10 articles)

1. GENERAL DATA			
1.1. Name of the course	Small rodents as a source of zoonoses	1.6. Course teacher(s)	Prof. Josip Margaletić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/department-of-forestry/institute-of-forest-protection-and-wildlife-management/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	5 + 5 + 20
1.4. No. of the course	64	1.9. ECTS credits	7
1.5. Code of the course	DSZ16	1.10. Language(s)	Croatian ☐ English ☒

2. COURSE DESCRIPTION	
2.1. Course objectives	Students acquire knowledge about the causes of zoonoses in Croatian forest ecosystems in order to reduce the risk of infection. Defining the importance of zoonotic agents in forest ecosystems is a contribution to a better knowledge of natural relationships that are a guarantee of forest stability and preservation of human-managed forest ecosystems.
2.2. Course contents (syllabus)	Zoonoses (hemorrhagic fever with renal syndrome, lyme borreliosis, leptospirosis, lymphocytic choriomeningitis, tick-borne meningoencephalitis). Natural foci of zoonoses. Ecology of small rodents. Population abundance and dynamics. Sampling methodology for small rodents for virological analysis. Epizootics. Risk factors for zoonotic transmission. Serological analyzes of specific antibodies to pathogens of individual zoonoses. Methods of isolation of zoonotic agents. Molecular biology methods in the determination of zoonotic agents.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. List and describe the most important causes of zoonoses for which forest ecosystems are natural habitats. 2. Describe the spatial distribution of zoonotic agents. 3. Identify risk factors for zoonotic transmission. 4. To connect the ecology of small rodents with the appearance of zoonoses. 5. List and describe methods of isolation of zoonotic agents. 6. Interpret and interpret the manner of spreading (transmission) of zoonoses, recognize and describe the importance of forest ecosystems as natural habitats of zoonotic agents, and connect the risk of their employees from disease. 7. Design, plan and recommend measures to control the number of small rodents in forests as a method of preventive protection of human and animal health from certain zoonotic agents.

3. MONITORING AND EVALUATION OF STUDENT WORK						
	Class attendance	☒	Research	☒	Oral exam	☒

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Zabel, C.J., Anthony, R.G., 2003: Mammal Community Dynamics. Cambridge university press, 709 str.					
	Manning, A., Dawkins, M.S., 1998: Animal behaviour. Cambridge university press, 450 str.					
	Shakespeare, M., 2002: Zoonoses. Pharmaceutical Press, 285 str					
	Krebs, C.J., 2009: Ecology: The Experimental Analysis of Distribution and Abundance. Pearson, 655 pp.					
	American Society of Mammalogists, Animal Care and Use Committee. 1998. Guidelines for the capture, handling, and care of mammals as approved by the American Society of Mammalogists. Available at http://asm.wku.edu/commitees/.					
	Turk, N., Margaletić, J., Markotić, A., 2009: Forest ecosystems and zoonoses. Wildlife:Destruction, Conservation and Biodiversity / Harris, D. John ; Brown, L. Paul (ur.). Hauppauge, NY, USA : Nova Science Publishers, Inc., Str. 1-45					
4.2. Additional literature	Kanerva, M., Mustonen, J., Vaheri, A., 1998: Pathogenesis of Puumala and other hantavirus infections. Rev.Med. Virol., 8:67-86.					
	Štritof-Majetić, Z., Galloway, R., Ružić-Sabljić, E., Milas, Z., Mojčec-Perko, V., Habuš, J., Margaletić, J., Pernar, R., Turk, N., 2014: Epizootiological survey of mouse-like rodents as Leptospira spp. reservoirs in Eastern Croatia. Acta Tropica, 131: 111-116.					
	Vapalahti, O., Mustonen, J., Lundkvist, A., Henttonen, H., Plyusnin, A., Vaheri, A., 2003: Hantavirus infections in Europe. Lancet Infect. Dis., 3: 653-661.					
	Crawley, M.J., 1992: Seed-predators and plant population dynamics. In: Fenner, M., (Ed.), Seeds: The Ecology of Regeneration in Plant Communities. CAB International, str. 157-191.					
	Golley, F.B., Petrusewicz, K., Ryszkowski, L., 2009: Small mammals their productivity and population dynamics. Cambridge University Press, London-New York-Melbourne, 451 pp.					
	Cvetnić, S., 1993: Opća epizootiologija. Školska knjiga Zagreb, 10–139.					

	Jelena Prpić, Tomislav Keros, Marko Vucelja, Oktavija Đaković Rode, Josip Margaletić, Boris Habrun, Lorena Jemeršić, 2019: Full title: First evidence of hepatitis E virus infection in a small mammal (yellow-necked mouse) from Croatia. PLoS ONE 14(11): e0225583
	Linda BJEDOV, Petra SVOBODA, Ante TADIN, Josipa HABUŠ, Zrinka ŠTRITOF, Nikolina LABAŠ, Marko VUCELJA, Alemka ARKOTIĆ, Nenad TURK, Josip MARGALETIĆ, 2016: Utjecaj uroda sjemena obične bukve (Fagus sylvatica L.) na populacije sitnih glodavaca i pojavnosti hantavirusa u šumama Nacionalnog parka „Plitvička jezera“ i Parka prirode „Medvednica“. Šumarski list, 140(9-10): 455-464.

1. GENERAL DATA			
1.1. Name of the course	Taxonomy of infraspecific differentiation	1.6. Course teacher(s)	prof. Željko Škvorc, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/zeljko-skvorc/ https://www.sumfak.unizg.hr/en/about/general-information/staff/jozo-franjic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6+8+10
1.4. No. of the course	65	1.9. ECTS credits	7
1.5. Code of the course	DSZ17	1.10. Language(s)	Croatian ☒ English ☐

2. COURSE DESCRIPTION	
2.1. Course objectives	Develop the knowledge necessary for independent evaluation and implementation of research in intraspecific plant taxonomy. Get acquainted with the problems of intraspecific differentiation and nomenclature of natural and cultivated taxa. Develop skills of critical thinking in the field of plant taxonomy as well as independent design, implementation and analysis of scientific research.
2.2. Course contents (syllabus)	The concept and definition of a species, the problem of understanding the breadth of a species. Subspecies, variety, form - definitions, nomenclature and using of taxa. Other taxa used in forestry - cultivar, clone, etc. Genetic basis of infraspecific differentiation. Evolutionary processes that lead to the formation of various infraspecific taxa - mutation, recombination, dispersion, differentiation, isolation, hybridization, introgression, polyploidy. Vicarism. Identification of infraspecific taxa on characteristic examples - morphological, anatomical, physiological, phenological, biochemical, molecular and other features.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Analyze modern scientific knowledge in the field of infraspecific differentiation of plants. 2. Explain the problems of the nomenclature of natural and cultivated taxa lower than the species. 3. Independently design research in the field of taxonomy of infraspecific differentiation with the selection of appropriate methods for collecting and processing taxonomic data. 4. To correctly interpret the results of scientific research in the field of infraspecific differentiation.

3. MONITORING AND EVALUATION OF STUDENT WORK						
	Class attendance	☒	Research	☐	Oral exam	☒

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Rieseberg LH, Willis JH. 2007. Plant speciation. Science 317:910–914					
	Judd, W. S., C. S. Campbell, E. A. Kellogg, P. F. Stevens, M.J. Donoghue 2015: Plant Systematics. A Phylogenetic Approach. Sinauer Associates. Sunderland					
	Franjić, J., Ž. Škvorc, 2010: Šumsko drveće i grmlje Hrvatske. Sveučilište u Zagrebu – Šumarski fakultet, 432 str. Zagreb					
	Franjić, J., Ž. Škvorc, 2014: Šumsko zeljasto bilje Hrvatske. Sveučilište u Zagrebu – Šumarski fakultet, 626 str. Zagreb					
4.2. Additional literature	Templeton, AR 2006: Population Genetics and Microevolutionary Theory. Wiley-Liss.					
	Vidaković, M., J. Franjić, 2004: Golosjemenjače. Sveučilište u Zagrebu-Šumarski fakultet. Zagreb					
	Stuessy, T. F. 2009: Plant taxonomy - The systematic evaluation of comparative data. Columbia University Press, New York					
	Nikolić T., 2013: Sistematska botanika - Raznolikost i evolucija biljnog svijeta. Alfa d.d., Zagreb, 1 - 882.					
	Winston, J.E. 2000: Describing Species, Practical Taxonomic Procedure for Biologist. Columbia University Press, New York					
	+ selected scientific articles (up to 10 articles)					

1. GENERAL DATA			
1.1. Name of the course	Plant protection in urban areas	1.6. Course teacher(s)	prof. Danko Diminić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/department-of-forestry/institute-of-forest-protection-and-wildlife-management/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6 + 6 + 12
1.4. No. of the course	66	1.9. ECTS credits	7
1.5. Code of the course	DSZ18	1.10. Language(s)	Croatian ☒ English ☒

2. COURSE DESCRIPTION	
2.1. Course objectives	In urban areas, plants (trees and shrubs) live in specific habitat conditions and under a pronounced anthropogenic influence. The objectives of the course are to acquaint students with possible preventive and curative measures for plant protection, especially trees in urban areas in order to preserve their good health, with emphasis on environmentally friendly methods.
2.2. Course contents (syllabus)	In accordance with the specific conditions characterized by urban environments, plants, especially trees, are exposed to various abiotic and biotic adverse and harmful factors. Through this course, doctoral students are introduced to the factors that negatively affect the vitality and health of plants. Special attention is paid to current harmful insect species and pathogens, predisposing factors and negative anthropogenic effect, as well as to preventive and curative plant protection measures in order to preserve their good health, with emphasis on environmentally friendly methods.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Explain the role of fungal pathogens, harmful insect species, predisposing factors and harmful anthropogenic impact on trees and shrubs in urban areas. 2. Compare and interpret the possible harmful effects of these factors on plant health. 3. Analyze the most important and current pathogens and harmful species of insects in urban areas. 4. Analyze and interpret possible preventive measures for the protection of trees and shrubs using environmentally friendly protection measures and tree edotherapy. 5. Analyze and interpret possible curative measures for the protection of trees and shrubs using environmentally friendly protection measures, biological methods and tree edotherapy.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Igrc-Barčić, J., Maceljski, M., 2001: Ecologically acceptable plant protection against pests. Zrinski d.d., Čakovec, 247 p.					
	Diminić, D., 2021: Endotherapy of trees in pest and disease control - a review of current methods. Microsoft PowerPoint Presentation					
	Diminić, D., 2021: Biological methods of plant protection - a review of current methods. Microsoft PowerPoint Presentation.					
4.2. Additional literature	Bažok, R., D. Ivić, B. Cvjetković, K. Barić & Z. Ostojić, 2012: Review of plant protection products in Croatia for 2021. Plant Protection Bulletin, 21 (1-2): 320 p.					

1. GENERAL DATA			
1.1. Name of the course	Protected parts of nature	1.6. Course teacher(s)	Željko Španjol, Ph.D., Full Professor Daniel Krstonošić, Ph.D., Assistant Professor
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/zeljko-spanjol/ https://www.sumfak.unizg.hr/en/about/general-information/staff/daniel-krstonosic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6 + 4 +14
1.4. No. of the course	68	1.9. ECTS credits	7
1.5. Code of the course	DSZ19	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	Introduction to the categories of protected parts of nature (Nature Protection Act), NATURA 2000 areas; endangered categories (Red Books, Rulebook on strictly protected species). Overview of the elements needed to establish a protection institution. Understanding and application of current laws related to protected natural values. Methods of protection and review and evaluation of protected spatial parts of nature and rare, endangered and endemic species of flora and fauna. Identifying the causes of endangerement of flora and habitats and assessement of the negative impact on biodiversity.		
2.2. Course contents (syllabus)	Introduction to the issue of protection of biological and landscape diversity in the Republic of Croatia. Division and description of valuable parts of nature protected by law in the Republic of Croatia (proclamation, management, protection). Introduction to the spatial categories of protected parts of nature (national park, nature park, strict reserve, special reserve, regional park, natural monument, significant landscape, forest-park, monument of park architecture). Characteristics of the National Habitat Classification. European Ecological Network - NATURA 2000. Review and analysis of the state of endangerment of vascular flora in the World and Croatia (Red Books and Red Lists, Criteria and categorization of endangerment of flora and fauna according to IUCN). Main causes of endangerment and measures for protection of flora and fauna and impact on habitat types and reduction of biodiversity. Influence of alien invasive plant species on autochthonous		

	flora and fauna. Introduction to the most important representatives of protected plant species in the flora of Croatia (systematic affiliation, morphological characteristics and ecological requirements of species, distribution in Croatia and Europe).
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. To present the endangerment of flora and fauna, overview of endangered taxa in the Republic of Croatia (endangerment categories, methods and assessment criteria, legal protection, causes of endangerment, implementation of protection measures, endangered taxa, distribution, habitat). 2. To identify the causes of endangerment of flora and habitats and identify disadvantages and negative impacts on plant diversity. 3. To analyze protected areas within the European ecological network Natura 2000, legislative framework in nature protection, development of expert bases in nature protection and analysis of natural values. 4. To identify spatial categories of protection, national parks, nature parks and othe protection categories (historical development, spatial plans, zoning, management plans, financing). 5. Biological-ecological and landscape evaluation of protected parts of nature. 6. Reasons for endangering certain categories of protected parts of nature.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes						
	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☒		

4. LITERATURE LIST

4.1. Obligatory literature	Španjol, Ž., 1993: Uloga posebno zaštićenih objekata prirode u turizmu, Glas. šum. pokuse, posebno izdanje 4: 231-242, Zagreb.
	Španjol, Ž., 1994: Problematika nacionalnih parkova u svijetu i u Republici Hrvatskoj.
	Radović, J., 1999: Pregled stanja biološke i krajobrazne raznolikosti Hrvatske sa strategijom i akcijskim planovima zaštite. Zagreb: Državna uprava za zaštitu prirode i okoliša.

4.2. Additional literature	Nikolić, T., Topić, J., 2005: Crvena knjiga vaskularne flore Republike Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode.
	Topić, J., Vukelić, J., 2009: Priručnik za određivanje kopnenih staništa u Hrvatskoj prema Direktivi o staništima EU. Zagreb: Državni zavod za zaštitu prirode.
	Nikolić, T., Topić, J., Vuković, N., ur. 2010: Botanički važna područja Hrvatske. Zagreb: Školska knjiga, Prirodoslovno-matematički fakultet.
	Attenborough,D. i Hughes,J.,2000:Život na našem planetu-moje svjedočanstvo i vizija budućnosti, Školska knjiga d.d.,Zagreb.
	SABOR Republike Hrvatske, 1997: Propisi o zaštiti okoliša, Zagreb.
	World Resources 2000-2001: People and Ecosystems: The Fraying Web of life, 2000: Elsevier Science. Oxford.
	Ekološki leksikon, 2001: Barbat i Ministarstvo zaštite okoliša i prostornog uređenja RH. Zagreb.
	Martinić, I., 2010: Upravljanje zaštićenim područjima prirode - planiranje, razvoj i održivost. Sveučilište u Zagrebu, Šumarski fakultet, 368 str., Zagreb.

1. GENERAL DATA			
1.1. Name of the course	Time and Motion Study	1.6. Course teacher(s)	Prof. Željko Zečić, PhD Assist. prof. Dinko Vusić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/zeljko-zecic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/dinko-vusic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6 + 8 +10
1.4. No. of the course	70.	1.9. ECTS credits	7
1.5. Code of the course	DST1	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Mastering specific knowledge that enables competent planning, execution, supervision and independent decision-making in the field of complex tasks of wood extraction, technology development and acquisition of scientific research knowledge.		
2.2. Course contents (syllabus)	Time and motion study in timber harvesting is the basis of planning, preparation of work and control of production and payment for work performed. The motion study is the basis for shaping the work and its adaptation to the level of technical and technological development. With the help of motion studies, we clarify the factors that have an impact on work and work performance. Each work should be optimally designed, introduce the best and most appropriate technology and then use time studies to determine the required time for certain works. Students will be introduced to the basic settings of time and motion studies, concepts and meaning. The historical development of the time and motion study will be considered, and the beginning and first results of the application, ie rationalization of work, will be emphasized. It will then deal specifically with the area of work design, which encompasses the basic principles of lwork design, workers, means of work, and objects of work. An analytical and synthetic method of work design will be discussed. Time study is a part of the study of work on the basis of which the rationalization of work will be performed. The tasks of time studies consist of determining (measuring) the time of production of a product, analysis of effective times and analysis of downtime. Based on the recorded time, the calculation of the required time and the development of the time norm follow. For each type of work, a form is made with all the necessary data for the implementation of standardization of works. After the introductory part, the principles and components of time studies will be discussed. Methods of studying time with a practical part will be studied in detail. These		

	are the snap back and continuous method of chronometry and the method of instantaneous observations. The means, ie instruments and computer programs that are applied in the study of time in our country and in the world will be presented. The area of time classification of individual work operations and additional time will be treated separately. The recorded times are processed by mathematical-statistical methods, which will be discussed in a separate chapter. After the processing of the recorded data is completed, examples of norms on felling and production will be made, as well as for the means of work on skidding and forwarding wood assortments and in long-distance transport. In the final part, the area of the degree of effects, the purposes of applying the norms, the types of norms, the evaluation of work, the ways of rewarding, finding a better and cheaper way of working will be discussed.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) develop a plan for conducting time and motion studies with the corresponding forms, ie computer program settings; 2) conduct a time and motion study and analyze the collected results; 3) process the collected results by mathematical-statistical procedures; 4) construct a model for calculating productivity based on the main influencing factors.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☒	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Taboršak, D., 1987: Studij rada. Tehnička knjiga, Zagreb, 1–214.
	COST Action FP-0902, 2012: Good practice guidelines for biomass production studies. CNR IVALSA, Sesto Fiorentino, 1–51
	Olsen, E. D., Hossain , M. M., Miller, M. E., 1998: Statistical Comparison of Methods Used in Harvesting Work Studies. Forest Research Laboratory, Oregon State University, 1–41.

	Freese, F., 1967: Elementary statistical methods for foresters. US Department of Agriculture, Forest Service, Washington D. C., 1–87.
4.2. Additional literature	+ selected scientific articles (maximum 10 articles)

1. GENERAL DATA			
1.1. Name of the course	Forest Operations Management	1.6. Course teacher(s)	Prof. Željko Zečić, PhD Assist. prof. Dinko Vusić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/zeljko-zecic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/dinko-vusic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6 + 4 + 14
1.4. No. of the course	71.	1.9. ECTS credits	7
1.5. Code of the course	DST3	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Developing competent knowledge in the field of forest operations management, critical thinking skills and skills in independent design, implementation and analysis of work operations and application of new technologies.		
2.2. Course contents (syllabus)	Theoretical assumptions needed to manage production systems. Fundamentals of information theory. Cybernetics. Production management. Production preparation as part of the control system. Computer support for production preparation jobs. Production optimization. Fundamentals of technological systems design. Forest operations as technological activities aimed at the continuous supply of wood from the forest to the place of processing and accompanying activities that enable this flow. Management of timber harvesting in space and time. Tasks and objectives of forest operations management. Strategic, tactical and operational planning. Types of management structures. Cost management of timber harvesting. Monitoring productivity and determining efficiency within an organizational unit. The role of information and communication technology in forest operations management. Support for decision-making on optimal timber transport planning. The influence of the method of price formation on the choice of wood transport method. The influence of the type and quality of roundwood on the possibility of changing the transport plan.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) synthesize and critically discuss current scientific knowledge on the issue of forest operations management in the form of a seminar paper; 2) analyze the costs of timber harvesting;		

	3) evaluate the efficiency of the timber harvesting system; 4) design a technological system for timber harvesting wood.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Sundberg, U., Silversides, C.R., 1988: Operational Efficiency in Forestry – Volume 1: Analysis. Kluwer Academic Publishers – Forest Sciences, Dodrechts/Boston/Lancaster, 1 – 219.					
	Silversides, C.R., Sundberg, U., 1989: Operational Efficiency in Forestry – Volume 2: Practice. Kluwer Academic Publishers – Forest Sciences, Dodrechts/Boston/Lancaster, 1 – 169.					
	Grladinović, T., 1999: Upravljanje proizvodnim sustavima u preradi drva i proizvodnji namještaja. Udžbenik, Šumarski fakultet Sveučilišta u Zagrebu, 1 – 296.					
4.2. Additional literature	+ selected scientific articles (maximum 10 articles)					

1. GENERAL DATA			
1.1. Name of the course	Cost calculations of timber harvesting	1.6. Course teacher(s)	Prof. Tomislav Poršinsky, PhD Assist. prof. Andreja Đuka, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/tomislav-porsinsky/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/andreja-djuka/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	24: 6 + 6 + 12
1.4. No. of the course	72	1.9. ECTS credits	7
1.5. Code of the course	DST4	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	1) To give students an insight into the types of calculations and methods of compiling cost calculations, 2) To enable students to make cost calculations of typical timber harvesting systems.		
2.2. Course contents (syllabus)	Conceptual determination of costs. Theoretical bases of calculation. Types of calculations with respect to the moment of occurrence. Types of calculations with respect to a business event. Components of machine labor cost calculations in timber harvesting operations. Time and quantity values in calculations. Data sources for calculations. Determining the cost of individual calculation items (depreciation, interest on investments, insurance and garage costs, costs of spare parts, fuel and lubricants, repairs and maintenance, labor costs, overhead costs, profit). Peculiarities of calculations of felling and production, extraction and remote transport of wood.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) Performing cost calculations of timber harvesting operations, 2) Using advanced procedures to determine the cost milestone, 3) Evaluating the components of the cost calculation for forestry vehicles, 4) Evaluating the costs of individual calculation settings.		
3. MONITORING AND EVALUATION OF STUDENT WORK			

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☒		
4. LITERATURE LIST						
4.1. Obligatory literature	Miyata, Edwin S. 1980. "Determining Fixed and Operating Costs of Logging Equipment." USDA Forest Service North Central Forest Experiment Station. General Technical Report NC-55. St. Paul, Minnesota. 16 p.					
	Klobučar, D., Poršinsky, T., Đuka, A., 2018: Determining Conditions for Replacing Forest Vehicles Using Cash Flow Analysis FORMEC 2018 – Improved Forest Mechanisation: mobilizing natural resources and preventing wildfires, 196-208.					
	Brinker, R.W., Kinard, J., Rummer, B., Lanford, B., 2002: Machine Rates for Selected Harvesting Machines . Alabama Agricultural Experiment Station – Auburn University, 1–31.					
4.2. Additional literature	FAO, 1992: Cost control in forest harvesting and road construction. Forestry paper 99, Rome, 106 p.					
	Figurić, M., 2003: Menadžment troškova u drvnotehnološkim procesima – Izabrana područja za drvne tehnologe. Udžbenik, Šumarski fakultet Sveučilišta u Zagrebu, 249 p					
	Lan, Z., 2001: A cost model for forest machine operation in wood cutting and extraction. University of Helsinki, 1–15.					
	Berk, J., 2010: Cost Reduction and Optimization for Manufacturing and Industrial Companies. John Wiley & Sons, Hoboken New Jersey, and Scrivener Publishing, Salem, Massachusetts, USA, 258 p.					
	Mikkonen, E., Lan, Z., 1999: Cost and Production Modeling Tool for Wood Procurement Logistics. "Emerging harvesting issues in technology transition at the end of century" IUFRO Division 3, RGs: 3.04.00, 3.06.00 and 3.07.00, Opatija, 1-8.					

1. GENERAL DATA			
1.3. Name of the course	Trade of Forest Products	1.6. Course teacher(s)	Prof. Željko Zečić, PhD Assist. prof. Dinko Vusić, PhD
1.4. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/zeljko-zecic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/dinko-vusic/
1.6. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	8 + 8 + 8
1.7. No. of the course	73.	1.9. ECTS credits	7
1.8. Code of the course	DST6	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.4. Course objectives	Mastering specific knowledge that enables competent planning, execution, supervision and independent decision-making in the field of complex tasks of trade in forest products, and acquiring the basis of scientific research knowledge in the subject matter.		
2.5. Course contents (syllabus)	The subject is structurally divided into two parts. The first part deals with the area of trade in all wood products, and the second part covers the area of trade in all non-wood products of the forest. The first part covers the emergence, tasks and division of trade, then the description and types and characteristics and functions of the market. Special attention will be paid to the area of price development and the impact of the European and world markets on wood prices and forecasts of price changes. Then, the area of the theory of price formation of forest products and forms of price formation will be discussed. A special subchapter covers the technique of trading in forest wood products, which will show the places and means used in trade. Forms of sale of forest wood products with special emphasis on influential market factors will be further discussed. With regard to the condition, quantities, types and value of wood products in the Republic of Croatia, the trends in neighboring European countries will be elaborated. Then, the forms of sale of wood assortments (stumpage sale, sale at the landing, public bidding) will be discussed separately. Finally, the forms and components of the trade agreement and other legal acts will be processed. The second part of this course will cover the area of trade and the income of all non-wood products and the use of forests.		
2.6. Expected learning outcomes at the level of	1. synthesize and critically discuss current scientific knowledge in the field of trade in forest products and prepare written reports in the form of seminar papers;		

the course (4 to 7 learning outcomes)	2. statistically process data on international trade in forest products; 3. analyze the trends of prices of forest products, plan the prices of sales of forest products according to market forecasts and prepare written reports in the form of a seminar paper; 4. evaluate the effectiveness of certain ways of selling forest products.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	UNECE: Forest Products Annual Market Review (last edition).					
	Sabadi, R., 1998: Osnove trgovačke tehnike, trgovačke politike i marketinga u šumarstvu i drvnoj industriji, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 1-254.					
	Zečić, Ž., Vusić, D., 2020: Katalog drvnih šumskih proizvoda. Sveučilište u Zagrebu Šumarski fakultet, 1–182.					
4.2. Additional literature	+ selected scientific articles (maximum 10 articles)					

1. GENERAL DATA			
1.1. Name of the course	Timber harvesting and forest environment	1.6. Course teacher(s)	Prof. Tomislav Poršinsky, PhD Assist. prof. Andreja Đuka, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/tomislav-porsinsky/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/andreja-djuka/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	24: 8+ 8 + 8
1.4. No. of the course	74	1.9. ECTS credits	7
1.5. Code of the course	DST8	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	1) To give students an insight into the protocol for effective timber extraction in an environmentally sound way, 2) To enable students to analyze cost-effectiveness of environmentally friendly timber extraction technologies, 3) To train students to express the possibility of improving environmental performance of existing machines by changing their technical characteristics.		
2.2. Course contents (syllabus)	Effect of machinery used in timber harvesting on forest stands. Sources of environmental pollution. Legal bases and restrictions, declarations. Basic principles of transferring forces from the wheel to the ground. Forest soil compaction with different machines. Wheel rutting. Load-bearing capacity and damage to forest soils. The problem of vehicle and ground contact pressures. Possibilities of reducing vehicle contact pressures on forest soil. Compression and erosion of the soil, as a consequence of the movement of loaded vehicles during timber extraction in forest stand. Soil compaction measurement methods and its evaluation. Planning of secondary forest roads and defining position of tree felling as an organizational measure to reduce the level of damage. Methodology for measuring damage to standing trees. Techniques of physical protection of trees during timber extraction in forest stand. Required technical characteristics of machines for forest operations such as thinning, working on sloped terrain and soils with low bearing capacity in environmentally sensitive stands.		

2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) Performing measurements of damage to trees, saplings and root systems during vehicle movement, 2) Using advanced procedures for determining and assessing soil compaction, 3) Evaluation of wood harvesting technologies with regard to damage to the stand and soil and with regard to reducing CO2 emissions, 4) Evaluation of technical characteristics of vehicles for environmentally sensitive stands during timber extraction.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☒	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Saarilahti, M., 2002: Soil interaction model. Project deliverable D2 (W.p.No. 1) of the Development of a protocol for Ecoefficient Wood Harvesting on Sensitive Sites (ECOWOOD). EU 5th Framework Project Contract No. QLK5-1999-00991, 87 p					
	Dykstra, D.P., Heinrich, R., 1996: FAO model code of harvesting practice. FAO, Rome, 1–85.					
	Đuka, A., Poršinsky, T., Pentek, T., Pandur, Z., Janeš, D., Papa, I., 2018: Soil Measurements in the Context of Planning Harvesting Operations and Variable Climatic Conditions. SEEFOR 9 (1): 1-11.					
	Poršinsky, T., Matas, J., Horvat, D., Đuka, A., 2020: Pneumatici kotača šumskih vozila. Šumarski list 144 (9-10): 509-522.					
4.2. Additional literature	Đuka, A., Poršinsky, T., Pentek, T., Pandur, Z., Vusić, D., Papa, I., 2018: Mobility Range of a Cable Skidder for Timber Extraction on Sloped Terrain. Forests. 9 (9): 1-11.					
	Arnup, R.W., 1999: The extent, effect and menagement of forestry-related soil disturbance, with reference to implications for the Clay Belt: a literature review. Ontario Ministry of Natural Resources, Northeast Science & Technology, TR-37, 1–30.					
	Kellogg, L.D., 2000: Damage Characteristics in Young Douglas-fir Stands from Commercial Thinning with Four Timber Harvesting Systems. Western Journal of Applied Forestry 15(1): 27–33.					
	Han, H.-S., Kellogg, L.D., 2000: A Comparison of Sampling Methods and a Proposed Quick Survey for Measuring Residual Stand Damage from Commercial Thinning. Journal of Forest Engineering 11(1): 63–71.					

1. GENERAL DATA			
1.1. Name of the course	Primary and secondary forest opening	1.6. Course teacher(s)	Izv. prof. dr. sc. Hrvoje Nevečerel Doc. dr. sc. Kruno Lepoglavec
1.2. Name of the module (if applicable)	FOREST ROAD INFRASTRUCTURE	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/hrvoje-nevecerel/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/kruno-lepoglavec/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	7 + 7 + 10
1.4. No. of the course	75	1.9. ECTS credits	7
1.5. Code of the course	DST10	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Students are trained to successfully connect spatial data on the location of primary and secondary forest roads with adequate databases. They also acquire all the necessary competencies in the selection of current computer programs, methods and technologies and related tools that allow them to more clearly and accurately determine the unopened areas of commercial and protective forests and forested areas.		
2.2. Course contents (syllabus)	Through the course Primary and Secondary Forest Opening, PhD students are introduced to the basic settings of primary (forest roads) and secondary (tractor roads, tractor trails and cable yarder lines) forest opening. The relief areas are defined - lowland, hilly, mountainous and karst, with which different forest opening systems are connected. Factors that have an important impact on the spatial distribution of the primary and secondary network of forest roads are analyzed, and students get acquainted with each of the factors. The use of modern technologies based on GIS, GNSS, intensive use of personal computers, digital terrain models, 3D terrain representations, satellite images and drone images is presented and explained. There is talk of computer models of forest opening and computer simulations of individual solutions with an emphasis on the possibility of comparing different versions. Knowledge of simple and complex dominant factors that play a crucial role in the forest transport infrastructure planning phase is transferred. In practical work, students independently solve the problems of		

	opening forests in different stand and habitat conditions, with the application of modern techniques, technologies and methods of work.					
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Recognize and explain the types and importance of forest roads in each relief area 2. Describe the characteristics of individual relief areas and explain their impact on the primary or secondary network of forest roads 3. Evaluate the input data needed for the proper analysis of forest transport infrastructure and define the dominant factors 4. Explain the tools needed to create a digital network of forest roads of different relief areas 5. Establish the sustainability of individual models for different relief areas with regard to their specifics 6. To be able to critically discuss the subject with students and teachers based on read scientific articles					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Dietz, P., H. Löffler, & W. Knigge, 1984: Walderschließung, Eine Lehbruch für Studium und Praxis unter besonderer Berücksichtigung des Waldwegebaus. Verlag Paul Parey, Hamburg und Berlin, p. 1-196, odabrana poglavlja					
	Girvetz, E., F. Shilling, 2003: Decision Support for Road System Analysis and Modification on the Tahoe National Forest, Environmental Management, Volume 32, Issue 2, Sep. 2003, p. 218 - 233					
	Košir, B., Krč, J. 2000: Where to Place and Built Forest Roads - Experience From the Model. Journal of Forest Engineering 11(1): p. 7-19					
4.2. Additional literature	Hodić, I., Jurušić, Z. 2011: Analiza primarne otvorenosti šuma kojima gospodare HŠd.o.o. Zagreb kao podloga za kreiranje buduće politike izgradnje šumskih cesta, Šumarski list, Vol.135 No. 9-10, str. 487-499					
	Anderson, A.E., J. Nelson, 2004: Projecting vector-based road networks with a shortest path algorithm. Canadian Journal of Forest Research, 1 July 2004, vol. 34, no. 7, p. 1444-1457					

	Pentek, T., Pičman, D., Nevečerel, H. 2004: Environmental - ecological component of forest road planning and designing International scientific conference: Forest constructions and ameliorations in relation to the natural environment, Technical University in Zvolen, Slovakia, 16th - 17th September 2004. Proceeding CD/DVD MEDIJ, p. 94-102
	Pentek, T., Nevečerel, H., Dasović, K., Poršinsky, T., Šušnjar, M., Potočnik, I. 2010: Analiza sekundarne otvorenosti šuma gorskog područja kao podloga za odabir duljine uža vitla. Šumarski list 134(5-6): str. 241-248
	Rogers,L. 2005: Automating contour-based route projection for preliminary forest road designs using GIS. Master Thesis. University of Washington, p. 1-87
	Stuckelberger, J., A., 2007: A weighted-graph optimization approach for automatic location of forest road networks. PhD. Dissertation, Vdf Hochschulverlag AG an der ETH, Zürich
	Tarolli, P., Calligaro, S., Cazorzi, F., Dalla Fontana, G. 2013: Recognition of surface flow processes influenced by roads and trails in mountain areas using high-resolution topography. European Journal of Remote Sensing, 46: p. 176-197

1. GENERAL DATA			
1.1. Name of the course	Techniques and Technologies of Forest Road Construction	1.6. Course teacher(s)	Prof. Tibor Pentek, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/tibor-pentek/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	8 + 6 + 10
1.4. No. of the course	76	1.9. ECTS credits	7
1.5. Code of the course	DST12	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Through lectures and presentations, doctoral students gain knowledge of the latest scientific and professional achievements in techniques and technologies of forest road construction (forest roads of various categories and strip roads) in lowland areas and on sloping terrain, and in techniques and technologies for forest road maintenance. Students are trained to choose possible and suitable technologies for the construction and maintenance of forest roads (based on 5E criteria) in different relief areas. Through practical work, specific problems present in operational forestry are solved, such as: introduction of contractors, preparation of various minutes, supervision and control of construction and maintenance services, monitoring of construction books and construction diary, handover of constructed forest road, etc. Students prepare a study of forest road maintenance.		
2.2. Course contents (syllabus)	Through the course Techniques and Technologies of Forest Road Construction, students of doctoral studies gain knowledge about the procedures of forest road construction in lowland areas and on sloping terrain. Here we deal with the technological sequence of the process of construction and maintenance of forest roads and the construction and repair of strip roads, as well as with the construction machines used. The machines are broken down in detail into basic groups and subgroups with an adequate description. The theoretical and practical efficiency of each machine is determined. The organization of forest road construction sites is discussed. The problem of construction of forest facilities on soils of low or very low strength is presented with an overview of methods for improving the parent soil with different stabilization methods. The advantages and disadvantages of each stabilization method are pointed out, with special reference to the ecological requirements. The lecture also deals with various technologies for the construction of forest roads on sloping terrain susceptible to erosion.		

	Different types of pavements as well as dimensioning of pavement structures are considered. Students gain knowledge of the legal basis required for starting the construction and the necessary technical documentation. Students are also acquainted with the method of introducing contractors to work, making various minutes, supervision and implementation of work control, monitoring the construction logbook and the handover procedure of the constructed forest road.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Valorize the possible and recommend the suitable or optimal technology of construction / reconstruction and maintenance / repair of forest roads. 2. Evaluate and select the most suitable type and model of construction machine for various works of construction / reconstruction and maintenance / repair of forest roads. 3. Anticipate and explain possible problems in the construction /reconstruction of forest roads in lowland area or hilly and mountainous area (sloping terrain) and propose measures to avoid / minimize them.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	**Study**	☒
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	FAO, 1989: Watershed management field manual: road design and construction in sensitive watersheds. FAO Conservation Guide 13/5. FAO, Rome, Italy, p. 1-196.
	Slunjski, E. 1995: Strojevi u građevinarstvu, Hrvatsko društvo građevinskih inženjera, Zagreb, s. 1-250. Winkler, N. 1998: Environmentally Sound Road Construction in Mountainous Terrain, Food and Agriculture Organization of the United Nations, Rome, p. 1-54.
	Winkler, N. 1998: Environmentally Sound Road Construction in Mountainous Terrain, Food and Agriculture Organization of the United Nations, Rome, p. 1-54.

	Winkler, N. 1999: Environmentally sound forest infrastructure development and harvesting in Bhutan. Forest Harvesting Case-Study 12. FAO, Rome., p. 1-67.
	Ryan, T. et al., 2004: Forest Road Manual, Guidelines for the design, construction and management of forest roads, COFORD, Dublin, p. 1-156, odabrana poglavlja. Pičman, D., Pentek, T. 1996: Stabilizacija šumskih transportnih sustava vapnom, Mehanizacija šumarstva 21 (2), Zagreb, Hrvatska, s. 83-85.
4.2. Additional literature	Pičman, D., Pentek, T. 1996: Stabilizacija šumskih transportnih sustava vapnom, Mehanizacija šumarstva 21 (2), Zagreb,
	Pičman, D., Pentek, T. 1997: Različite mogućnosti primjene geosintetika kao metode stabilizacije tla pri gradnji šumskih cesta, Šumarski list vol. 121 (7-8), Zagreb, Hrvatska, s., 383-389.
	Lacrombe, G., 1999: Forest Roading Manual, Liro Forestry Solutions, New Zeland, p. 1-404, odabrana poglavlja.
	Cornell, J., Mills, K. 2000: Forest Road Management Guidebook, Oregon Department of Forestry, p. 1-32.
	Fannin, R.J. 2000: Basic geosynthetics: a guide to best practices. BiTech Publishers, Richmond, B.C., Canada, p. 1-86.
	British Columbia Ministry of Forests. 2001: Forest Practices Code, Forest Road Engineering Guidebook, 2nd edition. Government of British Columbia, Victoria, p. 1-208.
	Anon., 2002: Forest Road Engineering Guidebook, B.C. Ministry of Forests, p. 1-208, odabrana poglavlja.
	Anon., 2011: Colorado Forest Road Field Handbook, Colorado State Forest Service, p. 1-142, odabrana poglavlja.

1. GENERAL DATA			
1.1. Name of the course	PROMINENT CHARACTERISTICS OF WOOD	1.6. Course teacher(s)	Prof. Tomislav Sinković, PhD Assist. prof. Tomislav Sedlar, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/tomislav-sinkovic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/tomislav-sedlar/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	24 + 8 + 8
1.4. No. of the course	77	1.9. ECTS credits	7
1.5. Code of the course	DST 13	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Investigation of anisotropy of wood properties in relation to breeding measures carried out on stands.		
2.2. Course contents (syllabus)	Anisotropy of wood properties as an inevitable factor in the characteristics of wood and wood products. The anisotropy of wood structure elements, macroscopic characteristics, cross-sections and directions, textures, and all other physical characteristics of wood determine the possibility of application and use of wood and wood materials. Water in a living tree. Water distribution in the tree. Water movement in the tree. Methods of determining and expressing the water content in wood. Hygroscopicity of wood. Influence and significance of water in wood after demolition. Influence of water in wood during transport. Influence of water in wood in sales. The anisotropy of the mechanical properties of wood is especially evident in the material used in construction and wood structures. Anisotropy of mechanical properties of wood in terms of elasticity, hardness, strength and wear resistance. The relations of mechanical characteristics of wood with regard to the direction of load and the possibilities of application of certain types of wood with regard to the stated characteristics indicate the manner of application of wood and wood materials in building and structural elements. Irregularity of wood from the botanical-physiological point of view and from the technical-commercial point of view. Divisions or classifications of wood irregularities. Significance and importance of wood irregularities in the assessment, manufacture, sale, price, value, use and appearance of wood. Influence of wood irregularity on the technical value of wood.		

2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Stjecanje znanja za znanstveni pristup problematici fizikalnih i mehaničkih značajki drva kao materijala s neizbježnom karakteristikom anizotropnosti. 2. Kroz proučavanje anizotropnosti fizikalnih i mehaničkih značajki te usporedbe značajki obzirom na tri osnovna smjera stječu se spoznaje o mogućnostima primjene i upotrebe drva i materijala na bazi drva. 3. Proučavanje rasporeda i kretanja i promjene sadržaja vode u drvetu . Problematika promjena sadržaja vode u drvu nakon rušenja, izvlačenja, transporta i pri prodaji drva. Značaj sadržaja vode u drvu pri sječi, izradi, izvlačenju, transportu i prodaji drva. 4. Sveobuhvatni znanstveni pristup problematici nepravilnosti drva, njihovom definiranju i klasifikaciji. 5. Proučavanje mehanizama nastajanja nepravilnosti drva. Istraživanje utjecaja nepravilnosti na svojstva drva, upotrebu drva, vrijednost i izgled. 6. Mogućnosti primjene nepravilnosti drva kao posebnih i znakovitih upotrebnih i estetskih elemenata kod određenih proizvoda iz drva.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes						
	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	
	Kollmann F. R., Cote, W. A. Jr. 1968:Principles of Wood Science and Technology l solid Wood, New York, str. 1-592.
	Giordano, G.1971: Tecnologia del legno, Volume l, Torino, str. 1-924.
	Skaar, C. 1972:Water in Wood, Syracuse University Press, Syracuse, New York, str. 1-218
	Horvat, I.1976: Tehnologija drva l, skripta, Zagreb, str. 1-280.
	Tsoumis, G.1991: Science and Technology of Wood, New York,str. 1-233.
	Foest 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.

4.2. Additional literature	Horvat, I.;Bađun, S.; Govorčin, S. (1984): Fizička i mehanička svojstva bagremovine (Robinia pseudoacacia L.), Bilten ZIDI, 12 (5) 44-54.
	Govorčin, S.(1986): Neka fizičko-mehanička svojstva bukovine, Zbornik radova "Kolokvij o bukvi", Velika-Slavonska Požega, 109-115.
	Govorčin,S.; Sinković,T.; Trajković,J.(2003): Some physical and mechanical properties of beech wood grown in Croatia Wood research, vol. 48 (3); 39 - 52, Slovak Forest Products Research Institute, Bratislava 2003.
	Despot,R.; Trajković,J.; Sinković, T. (1999): The influence of type and colour of coat on durability of exterior fir wood joinery. "Surface properties and durability of exterior building components", str. paper 8, Zagreb.
	Govorčin, S., Sinković, T., Despot, R., Trajković, J., Šefc, B. (2001): Old-new types of wood in furniture production. International conference "WOOD-FUTURE MATERIAL IN FURNITURE DESIGN" str.89-96, Zagreb.
	Govorčin,S.; Sinković,T. (2000): Influence of double sapwood on the quality of Slavonian oak. "IUFRO Working groups: Improvement of wood quality and genetic diversity of oak" Glasnik za šumske pokuse, 37 (189-199).
	Bađun, S.; Govorčin, S.;Babić, J.,(1987): Električna svojstva i mjerenje sadržaja vode u drvu, Drvna industrija 38 (5/6) 111-116.
	Govorčin,S.; Sinković,T.; Trajković,J. (1998): Distribution of properties in use for oak, beech and fir-wood in radial direction. Raspored svojstava u radijalnom smjer pri upotrebi hrastovine, bukovine i jelovine. Drvna industrija, 49 (4)199-204.

1. GENERAL DATA			
1.1. Name of the course	Measurement techniques on forest machines	1.6. Course teacher(s)	Prof. Marijan Šušnjar Assist. Prof. Zdravko Pandur
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/marijan-susnjar/ https://www.sumfak.unizg.hr/en/about/general-information/staff/zdravko-pandur/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6+8+10
1.4. No. of the course	78	1.9. ECTS credits	7
1.5. Code of the course	DST17	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to acquaint doctoral students with the basics and procedures of measuring mechanical quantities of forest machines electrically, collecting and processing data from the stand system, methods of remote transmission of measurement data and above all interpretation of measurement results in order to make decisions on optimal use of forest machines.		
2.2. Course contents (syllabus)	Basic concepts of measurement technique, metrological information and measurement procedures. Algorithm and components of the measurement procedure. Frequent measuring sizes of forest machines. Calibration systems. Measurable insecurity. Measurement errors. Inaccuracy. Inaccuracy. Unreliability and uncertainty. Technical legislation. Metrology pyramid. Legal metrology. Scientific metrology. Production metrology. Defining measuring and testing centers. Concepts of scale, measuring chain and measuring device. Measurement of shapes and dimensions. Length measurement. Length standards. Thermal measurements. Temperature measurement. Basic terms. Thermometers. Pressure measurement. Measurement of forces, stresses and strains. Measurement of force by weights, dynamometers, strain gauges. Photoelasticimetry. Special methods for measuring forces, stresses and strains on forest machines. Measurement of dynamic quantities. Electrical measurements of non-electric quantities. Measuring chain. Dynamic measurements. Dynamic properties of measuring quantity and measuring device. Measuring transducers for measuring dynamic quantities. Measurement of		

	torques, speed, power, speed. Restrictions and interferences. Signal transmission, reception and processing. Fuel consumption measurement methods. Basics of measuring ergonomic features. Measurement of mechanical quantities on forest machines. Criteria for rapid determination of some physical properties of soil.					
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Analyze the metrological problem 2. Install a suitable measuring system 3. Carry out measurements of physical quantities 4. Analyze, process and display the measurement result					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Schicker, R., Wegener, G., 2002: Measuring Torgue Correctly. Hottinger Baldwin Messtechnik GmbH, Germany, 1-263.					
	Marenče, J., 2005: Spreminjanje tehničnih parametrov traktorja pri vlačenju lesa - kriterij pri izbiri delovnega sredstva. Doktorska disertacija. Biotehniška fakulteta Univerze u Ljubljani; Slovenija, 1-271.					
	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.					
	Šušnjar, M., 2005: Istraživanje međusobne ovisnosti značajki tla traktorske vlake i vučne značajke skidera, disertacija, Šumarski fakultet Sveučilišta u Zagrebu, 1 – 146.					
	Marenče, J., Šušnjar, M., 2019: Granične sile i mase tovara pri privitlavanju drva. Šumarski list 143 (11/12), 515-521.					
	HRN ISO norme koje definiraju postupke mjerenja					
4.2. Additional literature	Suvinen, A., Saarilahti, M., 2006: Measuring the Mobility Parameters of Forwarders using GPS and CAN Bus Techniques. Journal of Terramechanics 43(2), 237-252.					

	Ringdhall, O., Hellstrom, T., Wasterlund, I., Lindross, O., 2012: Estimating wheel slip for a forest machine using RTK-DGPS. Journal of Terramechanics, 49, 271-279.
	Lumsden, K., 2004: Truck Masses and Dimensions – Impact on transport efficiency. Masses and Dimensions SAG report. Department of Logistics and Transportation, Chalmers University of Techology, Gothenborg, Sweden.
	Ağbulut, Ü., Sarıdemir, S., Albayrak, S. Experimental investigation of combustion, performance and emission characteristics of a diesel engine fueled with diesel–biodiesel–alcohol blends. J Braz. Soc. Mech. Sci. Eng. 41, 389, 2019.
	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.
	Tomašić, Ž.,Šušnjar, M.,Horvat, D.,Pandur, Z., 2009: Forces affecting timber skidding. Croatian journal of forest engineering, 30 (2): 127-139.
	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.
	Pandur, Z., Šušnjar, M., Horvat, D., Zorić, M., Matajčić, M.,Ispitivanje tehničkih značajki nove šumske poluprikolice »Lika«. Nova mehanizacija šumarstva. 36 (2015) ; 19-32.

1. GENERAL DATA			
1.1. Name of the course	BUSINESS ETHICS	1.6. Course teacher(s)	Prof. Mario Šporčić, PhD Assist. Prof. Matija Landekić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/mario-sporcic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/matija-landekic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	12 + 0 + 12
1.4. No. of the course	79	1.9. ECTS credits	7
1.5. Code of the course	DST16	1.10. Language(s)	Croatian ☒ English ☐
2. COURSE DESCRIPTION			
2.1. Course objectives	1) to understand the role and significance of ethics as an important factor in modern business, 2) to comprehend and adopt ethical principles and relationships in business and management, 3) to master the necessary knowledge and skills to introduce and increase business ethics.		
2.2. Course contents (syllabus)	The course content includes the principles and meaning of business ethics: the issue of morality in the economy, social responsibilities, development of ethical ideology, modern ethical business theory, personal ethics, classification of ethical norms and principles, application of ethics in business decision making etc. Ethical behavior, factors influencing the development of personal ethics, principles of the power of ethics for the individual and for the organization, business etiquette and norms, informal rules of ethical behavior, stakeholders of business ethics, human rights in the context of business, entrepreneurship and economy. Separate thematic units are: ethical problems in business, sources and analysis of ethical problems; guidelines for making business decisions; ethics in different business situations, ethics in communication, ethics of business meetings, presentations; institutionalization of ethics - codes, laws, commissions; company policy and business culture; organizational culture and business ethics; development of ethical program, ethical standards, forms of teaching and raising ethical standards, control is carried out; recognizing unethical business conduct. In particular, the impact		

	of ethics on business operations, factors for the successful implementation of business ethics, ethical environment, socio-economic and legal framework, international business ethics and ethical principles in different cultures are discussed.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Analyze ethical issues. 2. Interpret the meaning and impact of ethics on business operations 3. Assess the level of corporate social responsibility and ethical performance of the company 4. Influence positive ethical attitudes and ethical behavior in the company 5. Introduce ethical standards and instruments for institutionalizing business ethics

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Vig, S., 2019: Poslovna etika. Codupo, Zagreb
	Bebek, B., Kolumbić, A., 2005: Poslovna etika. Sinergija nakladništvo, Zagreb.
	Kangrga, M., 2004: Etika – osnovni problem i pravci. Golden marketing – Tehnička knjiga.
	Singer, P., 2003: Praktična etika. KruZak, Zagreb
	Žitinski, M., 2006: Poslovna etika. Sveučilište u Dubrovniku, Dubrovnik
4.2. Additional literature	Ferrell, O. C., Fraedrich, J., 2002: Ethical Decision Making and Cases, Houghton Mifflin, New York.
	Šporčić, M., Landekić, M., Vondra, V., Anić, Z., 2010: Informacija o organizacijskoj kulturi u hrvatskom šumarstvu. Nova mehanizacija šumarstva, vol. 31: 15-26.
	Čehok, I., Koprek, I., 1996: Etika - priručnik jedne discipline, Školska knjiga, Zagreb.
	Klose, A., 1996: Poduzetnička etika. Školska knjiga, Zagreb.
	Primorac, I., 2006: Etika na djelu. KruZak, Zagreb.

	Čović, A., 2004: Etika i bioetika. Pergamena, Zagreb.
	Pharo, P., 2005: Sociologija morala. Masmedia, Zagreb.
	Singer, P., 2005: Jedan svijet: Etika globalizacije. Ibis-grafika, Zagreb.

1. GENERAL DATA			
1.1. Name of the course	Quantitative methods in research	1.6. Course teacher(s)	Assistant professor Azra Tafro, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/azra-tafro/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	15+10+10
1.4. No. of the course	80	1.9. ECTS credits	7
1.5. Code of the course	DDT 301	1.10. Language(s)	Croatian ☒ English ☒

2. COURSE DESCRIPTION	
2.4. Course objectives	1. Provide an introduction and overview of the main quantitative methods in the students' area of research. 2. Enable the students to independently perform needed calculations using the appropriate software. 3. Enable students to interpret and communicate the obtained results.
2.5. Course contents (syllabus)	Selected topics in operations research: Linear and nonlinear programming, Optimization problems. Introduction to decision theory: Decision trees, Multicriteria decision analysis. Selected topics in statistics: Parametric and nonparametric testing, Analysis of variance, Bayesian analysis, Multivariate analysis. Elementary signal processing: Fourier analysis, Digital and statistical signal processing.
2.6. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Proficiency in terminology and basic theoretical concepts of the methods covered. 2. Comprehending the scientific papers in their area of research and the mathematical concepts in them. 3. Using the appropriate software to perform quantitative analysis of their research results. 4. Interpret the mathematical results and communicate them in peer discussions and scientific papers.

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☐
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐

	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Kalpić, D., Mornar, V.: Operacijska istraživanja, DRIP, Zagreb, 1996.					
	Randall, R.B.: Frequency Analysis, Bruel&Kjaer, 1977.					
	Daly, F. et al: Elements of statistics, Addison - Wesley Publishing Company (1995)					
4.2. Additional literature	Selected scientific papers from the research area					
	Data analysis software (MATLAB, Python, R)					
	Peck, Roxy, Chris Olsen, and Jay L. Devore. Introduction to statistics and data analysis. Cengage Learning, 2015.					
	Orfanidis, Sophocles J. Introduction to signal processing. Pearson Education, Inc, 2016.Cortez, Paulo. Modern optimization					
	Cortez, Paulo. Modern optimization with R. New York: Springer, 2014.					

1. GENERAL DATA			
1.1. Name of the course	Chemical analysis of wood composition	1.6. Course teacher(s)	Assoc. Prof. Alan Antonović
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/alan-antonovic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	30 + 15 + 20
1.4. No. of the course	81	1.9. ECTS credits	7
1.5. Code of the course	DDT302	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Acquiring knowledge of various modern chemical instrumental methods used today for research and characterization of wood biomass as well as other types of lignocellulosic biomass. Identify and explain different sources of lignocellulosic biomass. Prepare lignocellulosic biomass samples as a pre-treatment for testing on various instruments. Describe and explain the work on different instruments for chemical analysis. Explain the chemical reactions that take place during chemical analysis on different instruments. Based on the obtained results on different instruments for chemical analysis, perform chemical characterization of lignocellulosic biomass. Learn to classify, distinguish, define and apply the results of chemical properties of lignocellulosic biomass in research and further application.		
2.2. Course contents (syllabus)	Determination of the quantitative and qualitative chemical composition of wood. Comparison between chemical classical analytical and instrumental methods in wood analyses. Introduction to modern chemical instrumental analyses of wood. Preparation of wood samples for chemical instrumental analyses. Elementary analysis. Potentiometric methods. Voltammetric and colorimetric methods. Molecular spectroscopy - ultraviolet and visible spectroscopy, fluorescence and phosphorus spectroscopy, Raman spectrometry. X-ray analytical methods - atomic fluorescence. Atomic absorption and emission spectrometry - optical instruments, optical atomic spectrometry, atomic absorption spectrometry, electrothermal atomic absorption spectrometry, inductively coupled plasma atomic emission spectrometry, x-ray spectrometry. Organic analytical methods - infrared spectroscopy, mass spectrometry, nuclear magnetic resonance spectroscopy. Electromagnetic methods - polarography. Chromatographic separation methods - gas chromatography, high-pressure liquid chromatography, liquid chromatography, ion chromatography, thin layer chromatography, supercritical fluid chromatography. Radiochemical methods - activation analysis, determination of the age of wood samples. Evolved gas analyses as hyphenate technology -		

	characterization of wood samples by the thermogravimetric analyzer, infrared spectrometer, gas chromatography, and mass spectrometer. Identification of obtained chemical compounds on different instruments. Characterization of the obtained results and further application.					
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. identify and explain different sources of lignocellulosic biomass for instrumental analyzes, 2. explain the manner and principle of operation of chemical instruments, 3. prepare samples and describe the chemical reactions that take place during the chemical analysis on the instrument, 4. identify the obtained chemical compounds on chemical instruments, 5. characterize the obtained chemical compounds, 6. compare the obtained results with previous research and analyzes, 7. apply the obtained results in further application.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☐
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☒	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	F. Rouessac; A. Rouessac (2013): Chemical analysis: Modern instrumentation methods and techniques. John Wiley & Sons,					
	A. Antonović (2018): Kemija drva (interna skripta). Šumarski fakultet, Zagreb					
	S. Vaz Jr. (2016): Analytical techniques and methods for biomass. Springer, Switzerland,					
4.2. Additional literature	B.K. Sharma (2000): Instrumental methods of chemical analysis (Analytical chemistry). GOEL Publishing house					

1. GENERAL DATA			
1.1. Name of the course	Investigation of adhesion and adhesives at wood gluing	1.6. Course teacher(s)	Assoc. Prof. Goran Mihulja, PhD.
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/goran-mihulja/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	15 + 20 + 0
1.4. No. of the course	82	1.9. ECTS credits	7
1.5. Code of the course	DDT 303	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.4. Course objectives	1) give students an introduction and overview of the basic adhesion theories and the most important factors of adhesion. 2) show students the widthnes of influencing factors responsible for adhesive contact formation and their application in the analysis of scientific research results, 3) to train students in basic analyzes of their own research results as well as the results of other researchers in the field of wood gluing, 4) to train students to independent thinking about the use of adhesives and adhesion and their modification in order to achieve optimal adhesive joints in wood gluing.		
2.5. Course contents (syllabus)	Adhesion theory. Contact angle, wetting and adhesion on wood. Wetting conditions. Properties of adherends and adhesives important for adhesive contact: wood surface roughness, spreading and penetration of adhesives, capillarity, surface tension and surface energy. Adhesion measurement. Modification of wood and / or adhesive for adhesion improvement. Interaction of wood and glue, formation of adhesive-cohesive bonds. Theoretical and realistic cohesive and adhesive strength. Formation of adhesive contact. Types of adhesives and their properties. Application of adhesives for a specific bonding process. Investigation of optimal gluing parameters. Investigation of physicochemical characteristics of adhesives and their influence on joint strength.		

	Investigation of wood surface characteristics and their influence on joint strength and durability. Investigation of tests and methods for measuring of glued joint strength. Research of wood gluing process.
2.6. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. to create and critically evaluate new scientific facts and findings in the field of research of adhesion and adhesives at wood gluing 2. analyze, interpret, critically reflect on new research problems in the field of adhesion and adhesives at wood gluing 3. independently scientifically research in the way of moving the boundaries of existing knowledge in the field of adhesion and adhesives at wood gluing and contribute to the creation of new knowledge 4. evaluate and improve the processes of adhesion and adhesives at wood gluing 5. to express oneself through scientific papers written according to scientific and professional standards 6. develop new ideas or processes, and responsibility for the success of research, the social usefulness of the results, and awareness of their possible negative consequences.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes						
	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	
	Bandel, A. 2009: Gluing Wood. Industrial press, Inc.
	Lučić, S., Kovačević, V., Packham D. E., Bogner, A., Geržina, A.: 2000: Stearate-modified calcium carbonate fillers and their
	Mezger, T.G. 2014: Applied Rheology. Anton Paar GmbH, Austria.
	Pizzi, A.: Advanced Wood Adhesives Technology, N.Y. 1994.
	Pizzi, A., Mittal, K. L. 2003: Handbook of Adhesive Technology, Second edition, Revised and Expanded. Marcel Dekker, Inc.,
	Various authors 2008: Core document of COST Action E34, Bonding of Timber, edited by: Dunky, M., Källander, B., Properzi,

4.2. Additional literature	Bogner, A. 1993a: Kvašenje drva i adhezija. Drvna ind. 44(4):139-143.
	Derbyshire, H.; Miller, E.R.; Turkulin, H. (1996): Investigations into the photodegradation of wood using microtensile testing.
	Minford, J.D. 1991:Treatise on Adhesion and Adhesives. N.Y.
	Various authors: Bonding of Modified Wood, Proceedings of the 5th COST E34 International Workshop, edited by Šernek,
	Rabiej, R.; Behm, H. D. 1992: The effect of clamping pressure and ortotropic wood structure on strength of glued bonds.
	Various authors: International contributions to Wood Adhesives Research, Forest Products Society annual meeting
	Stehr, M.; Östlund, S. 2000: An Investigation of the Crack Tendency on Wood Surfaces After Different Machining
	Zeppenfeld, G., Grunwald, D.: Klebstoffe in der Holz- und Möbelindustrie. DRW-Verlag, 2005.

1. GENERAL DATA			
1.3. Nme of the course	PLYWOOD OPTIMIZATION METHODS	1.6. Course teacher(s)	Prof. Mladen Brezović, PhD
1.4. NName of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/mladen-brezovic/
1.6. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	25+15
1.7. No. of the course	83	1.9. ECTS credits	7
1.8. Code of the course	DDT 304	1.10. Language(s)	Croatian ☐ English ☐

2. COURSE DESCRIPTION	
2.7. Course objectives	Acquisition of theoretical and applied knowledge that will enable independent scientific work in the field of research and application of materials and software tools for the development of optimized plywood
2.8. Course contents (syllabus)	Analysis of different theoretical models for predicting the plywood properties. Stress-strain relations of certain materials and its spatially orientation in the layers. Optimisation of plywood properties according to the predefined loads. Analysis of bending properties, normal stress, shear stress, panel buckling, material fatigue, impact loads. Predicting plywood strength according to the different failure theories. Analysis of crack propagation. Validation of numerical model results with experimental results. Influence of thermal effects on plywood stress and strain. Influence of moisture effects on plywood stress and strain.
2.9. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Analyze theoretical models predicting the properties of materials and plywood. 2. Analytically apply numerical methods in the analysis of plywood properties and propose an optimal model. 3. Application of software tools for analysis of materials and plywood. 4. Design the optimized plywood in accordance with the set aims.

3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☒	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐

	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Brezović, M., Pervan, S., Petrak, J., Prekrat, S.: Metoda procjene svojstava uslojenog drva. Drvna industrija, 69 (2018) 1, 49-54					
	Kljak, J., Brezović, M., Jambreković, V. 2006: Plywood stress optimisation using the finite element method. Wood research, 45					
	Kljak, J., Brezović, M., Jabreković, V., Antonović, A., 2005: Predviđanje mehaničkih svojstava funirske ploče. Međunarodno					
	Pellerin, R.F., Ross, R.J., 2002: Nondestructive Evaluation of Wood. Madison, Forest Products Society.					
4.2. Additional literature	Jecić, S., Semenski, D., 2001: Jednadžbe teorije elastičnosti. Fakultet strojarstva i brodogradnje, Zagreb.					
	Senjanović, I., 1998: Teorija ploča i ljuski. Fakultet strojarstva i brodogradnje, Zagreb.					

1. GENERAL DATA			
1.1. Name of the course	Wood-plastic composites	1.6. Course teacher(s)	Prof. Vladimir Jambreković, PhD Assist. Prof. Nikola Španić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/vladimir-jambrekovic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/nikola-spanic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	20 + 15 + 0
1.4. No. of the course	84	1.9. ECTS credits	7
1.5. Code of the course	DDT305	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.10. ourse objectives	1) to acquaint students with the important technological properties of wood, plastics and chemical additives and their importance in the design, on technological parameters defining and, on the impact, that they have on wood-plastic composites properties 2) to present and develop adhesive mechanisms in the wood-plastic relationship, explain the compatibility of applied chemical components and point out the influential parameters on the adhesive efficiency 3) to identify the specific properties of wood-plastic composites, present modern methods of their determination and analyse the properties of composites depending on the applied components and technological parameters 4) to show the influence of UV light, fungi, insects and termites and the effect of aging on the mechanical properties of wood-plastic composites		

	5) to process the possibilities of optimizing the wood-plastic composites properties by modification with cold plasma, silanes and silicones, liquid polybutadiene and other environmentally friendly chemical components
2.11. ourse contents (syllabus)	ESEM microscopic analyses of wood and annual plant fibres and research of their applicability for wood-plastic composites. Influence of wood flour obtained by steam explosion on the properties of wood-plastic composites. Effect of elastomers and binding agents on the contact efficiency of polypropylene filled with wood flour. Thermal and mechanical analyses of lignocellulose-polypropylene composites. Compatibility of wood and polyethylene in wood-plastic composites. Dynamical-mechanical properties of plastics reinforced with natural fibres. Adhesive mechanisms in wood-fibre-polypropylene composites. Analysis of surface activity on the properties of composites with waste plastic-fibrous materials. Influence of shear action on the orientation of cellulose fibres in aqueous suspension. Mechanism of additives in polymer stabilization. Influence of polypropylene crystallization on properties of wood fibre composites. Possibility of binding of lignocellulosic fibres and polyolefin matrix. Styrene-maleic anhydride wood fibre reinforced copolymers. Investigations of dimensional stability of wood-plastic composites exposed to elevated temperature. Improving the properties of bio-base fibrous-plastic composites by cold plasma treatment. The effect of ageing on the mechanical properties of wood-fibre composites previously treated with HDPE. Modification of biopolymers with silanes and silicones. Adhesion mechanism in wood fibre/polypropylene composites. Investigation of the improvement of cellulose fibre strength of LLDPE composites using liquid polybutadiene. Foaming problems regarding wood-fiber-plastic composites. Durability of wood-polymer composites against fungi, insects and termites. Photodegradation of wood-plastic composites.
2.12. xpected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) to identify the technological properties of wood, plastics and chemical additives and design wood-plastic composites properties 2) to explain the adhesive mechanisms in the wood-plastic relationship and determine the influential parameters on the adhesive efficiency 3) to determine the properties of composites by modern methods, explain the obtained results and perform optimization of technological parameters 4) to explain the impact of photodegradation of composites, the impact of biological pests and the effect of ageing on the mechanical properties of wood-plastic composites

	5) to optimize wood-plastic composites properties with environmentally friendly chemical components					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☐
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Španić, N. 2014: Karakterizacija biokompozitnih drvnih materijala pripremljenih sintetiziranjem acetilirane celuloze i celuloznih polimorfa. Doktorski rad, Šumarski fakultet, Zagreb, Hrvatska.					
	Stokke, D. D., Wu, Q., Han, G. 2013: Introduction to Wood and Natural Fiber Composites. John Wiley & Sons, Ltd., West Sussex, UK.					
	Oksman Niska, K., Sain, M. 2008: Wood-polymer composites. Woodhead Publishing and CRC Press LLC, Cambridge, UK.					
	Klyosov, A. A. 2007: Wood-plastic composites. John Wiley & Sons, Inc., New York, USA.					
4.2. Additional literature	Selected scientific papers					

1. GENERAL DATA			
1.1. Name of the course	Theory of wood product design development	1.6. Course teacher(s)	Prof. Boris Ljuljka, PhD, prof. emeritus; Assoc. Prof. Danijela Domljan, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.hatz.hr/hr/ljuljka-boris/ https://www.sumfak.unizg.hr/en/about/general-information/staff/danijela-domljan/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	25+0+5
1.4. No. of the course	85	1.9. ECTS credits	7
1.5. Code of the course	DDT 306	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	Mastering and understanding the theoretical, practical and methodological foundations of the process of developing the design of wood products as a complex interdisciplinary process. Developing the ability of independent analytical and creative design and activities.		
2.2. Course contents (syllabus)	Basics of the theory of wood product development. Significance of wood product design development. Theory of the process of product design development. Principles of new product development. Elements and subsystems within the development process. Management of the product development process and implementation on practical project tasks. The process of planning the development of wood product design. Conceptual approach to product development. Application of systematized methods. Methods of theoretical and experimental analysis of design solutions, analysis, synthesis, verification. Structuring the product design development process. Functions in the product design development process. Methods of monitoring, analysis and improvement of production solutions. Prototype development. Application of product development theory within production systems in wood processing, furniture production and wood products.		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Analyze development processes throughout history with an emphasis on the contemporary process of wood product design development. 2. Analyze and explain the purpose, goals and reasons for the application of design methods (primary and secondary research; survey, interview, observation, photography, video recording, anthropometric research, literature research,		

	marketing research, cultural analysis, focus groups, etc.), within development theory designing wood products and recognizing the effects of their application. 3. Evaluate theoretical, practical and methodological goals and methods of wood product design as part of a complex interdisciplinary process. 4. Manage the product design process in all stages of development (concept and implementation phases; concept creation and search, previous research and problem definition, project feasibility assessment, concretization of conceptual solutions, concept checking and extension; product development and concept development, sample design, value analysis and verification, realization, prototyping, trial series, solution evaluation, product launch and monitoring). 5. Critically discuss and analyze the read proposed literature and scientific articles with fellow students and teachers.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Baxter, M. (2002): Product design, A practical guide to systematic methods of new product development, Nelson Thornes
	Berman, D.B. (2009): Do Good Design. New Riders & AIGA Design Press, USA
	Kolter, P., Keller, K.L., Martinović, M. (2014): Upravljanje marketingom. MATE d.o.o, Zagreb
	Laurel, B. (2003): Design research, methods and perspectives, Massachusetts Institute of Technology, The MIT Press,
	Marchus, G.H. ((2002): What is design today, H.N. Abrams Inc. , New York
	Papanek, V. (1973): Dizajn za stvarni svijet, M. Marulić, Split
4.2. Additional literature	Domljan, D. (2011.) Oblikovanje školskog namještaja kao preduvjet očuvanja zdravlja učenika, disertacija, odabrana poglavlja,
	Domljan, D., Grbac, I., Bogner, A. (2004): Uloga dizajna u procesu razvoja školskog namještaja, Drvna industrija, vol 55, 2/04,

	Keller, G. (1995): Dizajn, Vjesnik , Agencija za marketing, Zagreb, odabrana poglavlja
	Lewrick, M.; Link, P.; Leifer, L. (2018): The Design Thinking Playbook: Mindful digital transformation of teams, products,
	Lidwell, W., Holden, K., Butler, J. (2006) : Univerzalna načela dizajna, Mate, Zagreb
	Luchs M.G. Swan S.; Griffin, A (2015): Design Thinking: New Product Development Essentials from the PDMA. Willey, New
	Vlaović, Z. (2009): Činitelji udobnosti uredskih stolica, disertacija, Sveučilište u Zagrebu, Šumarski fakultet, Zagreb

1. GENERAL DATA			
1.1. Name of the course	Methods optimization of wood raw material yields	1.6. Course teacher(s)	Assoc.Prof. Josip Ištvanić, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/josip-istvanic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	20 + 15
1.4. No. of the course	86	1.9. ECTS credits	7
1.5. Code of the course	DDT 308	1.10. Language(s)	Croatian ☒ English ☐

2. COURSE DESCRIPTION	
2.1. Course objectives	Complement the basic knowledge necessary to know the success of sawmill wood processing. Get acquainted with the techniques and methods of optimizing the use of sawmill processing of wood raw materials.
2.2. Course contents (syllabus)	Success indicators of sawmill processing of logs. Recovery of sawmill logs, Log yield in the form of sawnwood (quantitative, qualitative and value), Integral log yield. Success criteria for sawmill processing of logs. Factors effecting log yield. Log yield in classical sawmill processing. Log yield in the technology of dimension stocks. The importance of the sawblade arrangement. Criteria for composing a successfull sawblade arrangement. Determination of the sawing methods and of the sawblade arrangement. Simulated sawing. Experimental sawing.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Calculate and evaluate the success of sawing wood raw material according to the criteria of quantitative, qualitative and value yield of round and sawn wood, 2. Optimize the success of sawing according to the criteria of quantitative yield of round and sawn wood, 3. Optimize the success of sawing according to the criteria of qualitative and value utilization of round and sawn wood, 4. Optimize and propose possible technological improvements in the existing sawmill production, 5. Optimize the capacities of machines in the sawmill, 6. Plan, organize and optimize sawmill production at a strategic level.

3. MONITORING AND EVALUATION OF STUDENT WORK						
	Class attendance	☒	Research	☒	Oral exam	☒

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Experimental work	☐	Report	☒	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Brežnjak, M. 1997: Pilanska tehnologija drva, I dio, Udžbenik, Sveučilište u Zagrebu, Šumarski fakultet (odabrana					
	Brežnjak, M. 2000: Pilanska tehnologija drva, II dio, Udžbenik, Sveučilište u Zagrebu, Šumarski fakultet (odabrana					
4.2. Additional literature	Merzelj, F. 1996: Žagarstvo: Udžbenik, Kmečki glas, Ljubljana.					
	Gornik Bučar, D.; Merzelj, F. 1998: Žagarski praktikum, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za lesarstvo.					
	Nikolić, M. 2004: Prerada drveta na pilanama, udžbenik, Univerzitet u Beogradu, Šumarski fakultet, Beograd					
	Dević, I.; Ištvanić, J., 2003: Alati i strojevi u obradbi drva 1, Element, Zagreb. (odabrana poglavlja)					
	Goglia, V. 1994: Strojevi i alati za obradu drva I dio, Sveučilište u Zagrebu, Šumarski fakultet. (odabrana poglavlja)					
	Szymani R. 1999: Scanning Technology & Process Optimization, Miller Freeman Books.					
	Williston Ed M. 1988: Lumber manufacturing: The design and operation of sawmills and planer mills, revised edition,					

1. GENERAL DATA			
1.3. Name of the course	CHANGES IN WOOD PROPERTIES	1.6. Course teacher(s)	prof.dr.sc. Tomislav Sinković, PhD assist. prof. Tomislav Sedlar, PhD
1.4. Name of the module (if applicable)	WOOD SCIENCE	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/tomislav-sinkovic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/tomislav-sedlar/
1.6. Status of the course	obligatory course	1.8. Structure of teaching (number of hours: L + E + S)	40 + 20 + 20
1.7. No. of the course	87	1.9. ECTS credits	7
1.8. Code of the course	152303	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.7. Course objectives	Research and comparison of properties of recent, naturally modified and modified wood.		
2.8. Course contents (syllabus)	Investigation of the properties of modified and recent wood. Defining and classifying trunk shape irregularities that cause the appearance of modified wood. Study of natural and artificial modifications of tree species. Determination and comparison of recent wood with wood caused by wood defects. Determination and comparison of properties of recent wood and wood from modified trees. Determination and analysis of wood properties from modified trees that are significantly different from the properties of recent wood and expand the field of application of wood as a material. Macroscopic and aesthetic properties of wood from modified trees as an advantage over recent wood. Analyze the procedures of physical, chemical and mechanical modifications of wood. Investigation of the phenomena and mechanisms that occur in wood during physical, chemical and mechanical wood modification processes. Investigation of the properties of modified wood by different methods. Comparative analysis of the properties of modified and recent wood.		
2.9. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Investigation of the properties of recent wood and its properties. 2. Investigation of the properties of naturally modified wood. 3. Investigation of the properties of modified wood. 4. Comparisons of properties of recent, naturally modified and modified wood.		

	5. Comparative analysis of the properties of recent, naturally modified and modified wood.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☒	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Kollmann,F.P.1968:Principles of Wood Science and Technology, I Solid Wood, Berlin, str.79-551.					
	Giordano, G.1971: Tecnologia del legno, Volume l, Torino, str. 671-924.					
	Tsoumis, G.1991: Science and Technology of Wood, New York,str. 1-233.					
4.2. Additional literature	Govorčin,S.; Sinković,T. (2000): Influence of double sapwood on the quality of Slavonian oak. "IUFRO Working groups: Improvement of wood quality and genetic diversity of oak" Glasnik za šumske pokuse, 37 (189-199).					
	Govorčin, S., Sinković, T., Despot, R., Trajković, J., Šefc, B. (2001): Old-new types of wood in furniture production. International conference "WOOD-FUTURE MATERIAL IN FURNITURE DESIGN" str.89-96, Zagreb.					
	Sinković,T.,Govorčin,S.,Sedlar,T.,2012:Comparision of physical properties of heat treated and untreated hornbeam wood,beech wood, ash wood and oak wood.The 5-nd International Symposium "Hardwood research and utilization in Europe 2012", Volume 1., str. 63-70, Sopron.					

1. GENERAL DATA			
1.1. Name of the course	Financial valuation of investments in forestry	1.6. Course teacher(s)	Assistant prof. Karlo Beljan, PhD
1.2. Name of the module (if applicable)	-	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/karlo-beljan/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	12+6+6
1.4. No. of the course	88	1.9. ECTS credits	7
1.5. Code of the course	DSZ24	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1. provide insight into the possibility of investing in forests (direct purchase of forests and/or by buying shares of publicly-traded companies that hold forests as an asset on stock exchanges), apropos provide the insight about possibility of mergers and acquisitions between private forestry companies, 2. learn the basic theoretical concepts and models for valuating financial assets, real assets, companies as a whole and various alternative assets, 3. learn the specifics of valuating investments in forestry and acquire advanced knowledge of valuation for the developed capital markets, 4. present and justify the advantages of investing in forests from the aspect of investment risk diversification (i.e. from the aspect portfolio investor).		
2.2. Course contents (syllabus)	The course at this level of study prepares the student for scientific research and practical activities in the field of financial analysis for forest resources and forestry business. In the introductory part of the course, the student will get acquainted with the characteristics of forests from the aspect of investing. In this sense, the investment in forests is analyzed in relation to some other investment opportunities, ie other sectors that are not necessarily in the domain of renewable natural resources. The course was developed with the aim to teach students to understand the concept of the value and different valuation methods and to understand the valuation of investments in forestry. Starting from the value of investments in financial, real and intangible assets, participants will be introduced to the economic value as the dominant concept of value for long-term investments. A special part of this course is aimed at acquiring key advanced knowledge in the field of value management of		

	profit-oriented forest enterprises whose value derives from the earning power of the portfolio of forests under their management. By this course, the participants will learn basic valuation techniques and other advanced knowledge in the field of investment valuation. In this sense, participants will be introduced to different models of present value, different approaches to determining the required rate of returns, and other models of valuing complex investments and alternative investment assets. In addition, from the investor's point of view (whose portfolios can be diversified to varying levels) the impact of forest investments on the overall risk-profit characteristics of the investment portfolio will be studied. In accordance with the growing importance of the Paris Agreement, carbon trading, the Responsible Banking Initiative and the Global Ethical Finance Initiative, the learning outcomes of this course will include the area of responsible investment, i.e. investment in sustainability.					
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Acquire relevant knowledge about the financial analysis (with an emphasis on the forestry), 2. Analyze various investments in forestry and apply appropriate value concepts for their valuation, 3. Systematize, classify and assess the impact of key fundamental factors that determine the profitability of investments in forests (i.e. investments in publicly-traded forestry companies), 4. Detect the importance of forests as investment opportunity and analyze the inclusion of investments in forests in the investor's overall investment portfolio, 5. Synthesize the knowledge from the field of responsible investing and connect this knowledge-outcomes with the characteristics of investing in forests and forestry-based businesses.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Klemperer WD. Forest Resource Economics and Finance. New York: McGraw-Hill; 1996. 551 p.					
	Hyde WF. The global economics of forestry. The Global Economics of Forestry. Abingdon; 2012. 1–478 p.					

	Orsag S, Dedi L. Budžetiranje kapitala-Procjena investicijskih projekata. Andrašić V, editor. Zagreb: Masmedia; 2011. 416 p.
	Gyawali B. Capital Asset Pricing Model in Forestry: A Review of Methods and Applications. BOKU Vienna, 2008
	Damodaran A. Investment valuation. 2nd edition. Wiley Finance. New York: John Wiley & Sons, Inc.; 2002. 992 p
	Orsag S. Investicijska analiza, HUFA, Avantis, 2015.
4.2. Additional literature	Siegel JJ. Triumph of the Optimists. Princeton University Press, 2002. . J Pension Econ Financ. 2003;2(1):91–5
	Amacher GS, Ollikainen M, Koskela E. Economics of Forest Resources. Cambridge, MIT; 2009. 397 p
	Chudy RP, Cubbage FW. Research trends: Forest investments as a financial asset class. For Policy Econ. 2020;119.
	Cubbage F et al. Global timber investments, 2005 to 2017. For Policy Econ. 2020;112:1–12
	Busby et al. Constructing optimal global timberland investment portfolios. ForPolicyEcon. 2020;111(Nov 2019):102083.
	Chudy RP et al. Profitability and risk sources in global timberland investments. ForPolicyEcon. 2020;111(Oct 2019):102037.
	Beljan K et al. Investment Potential of Private Forests in Croatia. Small-scale For. 2020;19(1):19–38.
	Miloš Sprčić D. Upravljanje rizicima. Zagreb: Sinergija; 2013. 208 p.

1. GENERAL DATA			
1.1. Name of the course	Quantitative Genetics of Forest Trees	1.6. Course teacher(s)	Prof. Saša Bogdan, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/sasa-bogdan/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6 + 6 + 12
1.4. No. of the course	89	1.9. ECTS credits	7
1.5. Code of the course	DSU23	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) to teach students theoretical assumptions of quantitative genetics applied to forest trees. 2) to train students to apply the methods of quantitative genetics (design and analysis of genetic testing). 3) to train students to apply the results of analyzes in practical forest management and in planning a strategy for genetic diversity conservation of forest trees.		
2.2. Course contents (syllabus)	Depending on prior knowledge and needs, students can acquire basic knowledge in the field of quantitative genetics of forest trees: Introduction to quantitative genetics (definitions, assumptions); Genetic testing (provenance test, progeny test, clonal test); Determination of quantitative genetic parameters; Interaction of genotype with environment. Genetic test design; Statistical analysis of genetic test data; Calculation of quantitative genetic parameters; Determination of racial differentiation by genetic testing; However, students can also acquire upgraded knowledge that accompanies development of professional and scientific achievements in the field and narrower and specific current issues (eg specific methodology for analyzing quantitative traits in forest stand management, etc.)		
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. To explain the inheritance of polygenic traits, the methodology of quantitative genetics, genetic testing in forest trees. 2. To calculate quantitative genetic parameters that describe: the level of genetic diversity of the population, the level of genetic differentiation of populations and the effective size of the population. 3. To discuss the state of genetic diversity of the population based on the calculated parameters. 4. To design a genetic test for the analysis of quantitative phenotypic traits, explain the process of collecting data from the genetic test.		

	5. To analyze genetic test (statistical data processing, calculate basic parameters of quantitative genetic diversity).					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	White, T. L., W. T. Adams, D. B. Neale, 2007: Forest Genetics. Wallingford, UK, Cambridge, CAB International. p682.					
	Fins. L, S.T. Friedman, J.V. Brotschol, 2010: Handbook of Quantitative Forest Genetics. Springer. p.406. ISBN: 9789048141128.					
4.2. Additional literature	Selected scientific articles suitable for the specific needs of the student					

1. GENERAL DATA			
1.1. Name of the course	Molecular Genetics of Forest Trees	1.6. Course teacher(s)	Asst. Prof. Ida Katicic Bogdan, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ida-katicic-bogdan/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	6 + 6 + 12
1.4. No. of the course	90	1.9. ECTS credits	7
1.5. Code of the course	DSU24	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) to teach students theoretical assumptions of selected methods of molecular genetics applied to forest trees. 2) acquaint students with the basics of molecular laboratory analysis using different systems of molecular markers. 3) students are introduced to the basics of statistical analysis of molecular analysis data and interpretation of the obtained results. 4) train students to apply the results of analysis in practical forest management, planning a strategy for the conservation of genetic diversity of forest trees and breeding of forest trees.		
2.2. Course contents (syllabus)	Depending on prior knowledge and needs, students can acquire basic knowledge in the field of molecular genetics of forest trees: Introduction to molecular genetics methods (definitions, basics), marker systems and their application (different types of markers for different research purposes, methodology, sampling methods); Fundamentals of laboratory procedures in molecular analysis; Statistical analysis - determination of genetic parameters and application of statistical programs; Application of molecular analysis data in population genetics, phylogeny or spatial genetics; application in practical forest management and conservation of genetic diversity of forest trees; basics of application of molecular methods in breeding (Marker Asisted Selection); basics of application of epigenetic markers. However, students can acquire upgraded knowledge that accompanies the development of professional and scientific achievements in the field and narrower and specific current issues (eg specific methodology of molecular analysis in forest stand management, transport of forest reproductive material, etc.)		
2.3. Expected learning outcomes at the level of	1. To explain the inheritance of polygenic traits, the methodology of quantitative genetics, genetic testing in forest trees. 2. Explain the concept of molecular marker, different selected marker systems and their application in forestry, considering the way of their inheritance and position in the genome.		

the course (4 to 7 learning outcomes)	3. Explain the sampling methodology, depending on the objectives of the research, describe the course and explain the basic laboratory procedures in the application of molecular markers. 4. Calculate basic genetic parameters describing the level and distribution of genetic diversity within and between populations 5. Based on the results, explain the distribution of genetic diversity in the area, the level of genetic diversity of populations and the basis of the possible origin of stands. 6. Explain the basics of research using epigenetic markers. 7. Explain the basics of molecular marker-assisted breeding.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	White, T. L., W. T. Adams, D. B. Neale, 2007: Forest Genetics. Wallingford, UK, Cambridge, CAB International. p682.					
	Ambriović Ristov, A., Brozović, A., Bruvo Mađarić, B., Ćetković, H., Herak Bosnar, M., Hranilović, D., Katušić Hećimović, S.,					
	HAHN, Matthew William. Molecular population genetics. Oxford University Press, 2018.					
4.2. Additional literature	Selected scientific articles suitable for the specific needs of the student.					

1. GENERAL DATA			
1.1. Name of the course	Vitality and extraordinary mortality of forest trees	1.6. Course teacher(s)	Prof. Ivica Tikvić, PhD Assoc. Prof. Damir Ugarković, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/ivica-tikvic/ https://www.sumfak.unizg.hr/hr/o-fakultetu/opci-podaci/djelatnici/damir-ugarkovic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	15 + 0 + 15
1.4. No. of the course	91	1.9. ECTS credits	6
1.5. Code of the course	DSU25	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1. Get acquainted with the processes of reducing the vitality and extraordinary mortality of forest trees 2. To present the abiotic causes of reduced vitality and extraordinary mortality of trees of the main tree species in Croatia 3. To enable students to analyze the causes and consequences of reduced vitality and extraordinary mortality of forest trees in Croatia and Europe 4. To enable students to monitor the damage, extraordinary mortality and vitality of forest trees		
2.2. Course contents (syllabus)	Explanation of the process of extraordinary mortality and reduction of vitality of forest trees. Ways of monitoring the extraordinary mortality, damage and vitality of forest trees. Influence of climate change and drought on the extraordinary mortality of forest trees. Relationships of hydrological factors and extraordinary tree mortality. The impact of weather disasters (wind, ice, snow) on the extraordinary mortality of trees. Relationships between air pollution and extraordinary tree mortality. Fire and consequences of tree mortality. Causes and consequences of extraordinary mortality of pedunculate oak trees in Croatia. Causes and consequences of the mortality of narrow-leaved ash trees. Causes and consequences of the		

	mortality of sessile oak trees. Causes and consequences of the mortality of european beech trees. Causes and consequences of the mortality of silver fir trees. Causes and consequences of the mortality of common spruce trees. Causes and consequences of the mortality of holm oak trees. Causes and consequences of the mortality of pubescent oak trees.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Describe and analyze patterns of extraordinary mortality of forest tree trees. 2. Present the state of damage, intensities of extraordinary mortality and vitality of forest trees. 3. Describe and explain the consequences of extraordinary tree mortality. 4. Make an analysis of the causes and consequences of extraordinary mortality and reducing the vitality of forest trees. 5. Assess the vitality of forest trees.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Klepac, D. (ur.), 1996: Hrast lužnjak (Quercus robur L.) u Hrvatskoj. HAZU i Hrvatske šume d.o.o., Vinkovci - Zagreb, 559 str.
	Matić, S. (ur.), 2003: Obična bukva (Fagus sylvatica L.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 855 str.
	Matić, S. (ur.), 2011: Šume hrvatskog Sredozemlja. Akademija šumarskih znanosti, Zagreb, 740 str.
	Prpić, B. (ur.), 2001: Obična jela (Abies alba Mill.) u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 895 str.
	Tikvić, I., i sur., 2018: Branimir Prpić - Ekologija šuma i šumarstvo. HŠD, ŠF, Zagreb, str. 430.
	Vukelić, J. (ur.), 2005: poplavne šume u Hrvatskoj. Akademija šumarskih znanosti, Zagreb, 455 str.
4.2. Additional literature	Ferretti, M., R. Fischer, 2013: Forest Monitoring. Elsevier, Oxford, 507 str.
	Kimmins J.P. 2004.: Forest Ecology. Prentice Hall, New Jesey, 611 str.
	Oršanić, M. i sur., 2020., Ekologija, obnova i zaštita poplavnih šuma Posavine. Šumarski fakultet, Zagreb, 368 str.

	Tikvić, I., D. Ugarković, 2021: General and Landscape Ecology of Temperate Forest Ecosystems. FŠDT, Zagreb 540 str.
	Waring, R., S. W. Running, 2007: Forest Ecosystems. Elsevier Academic Press, 420 str.

1. GENERAL DATA			
1.1. Name of the course	Human resources policy theory in wood technology companies	1.6. Course teacher(s)	prof. Denis Jelačić, PhD.
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	Denis Jelačić | Faculty of Forestry and Wood Technology (unizg.hr)
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	16 + 0 + 10
1.4. No. of the course	92	1.9. ECTS credits	7
1.5. Code of the course	DDT 309	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	To enable the student for projecting, structuring and evaluating the human resource management system in wood processing and furniture manufacturing.		
2.2. Course contents (syllabus)	Human resources policy in a company. Role and place of human resources policy in wood technology companies. Determination of human resources policy in a company. Sociologic, demographic, economic and business settings for determination of human resources policy in wood technology company. Strategic human resources management in a company, determination of human resources requirements regarding the human resources policy in a company. Determination of work posts systematisation in a company. Methods and techniques for establishing the system of selection, alloaction and training of human resources in a company. Determination of employees development system, determination of the system and structure of the work evaluation methods in a wood technology company. Law requirements, requirements of the community when establishing the system of human resource management in a company. Methods and techniques for evaluation of the human resources management system in wood technology company.		
2.3. Expected learning outcomes at the level of	1. To project the human resources policy system in wood technology company. 2. To determine the factors of human resources policy in a company.		

the course (4 to 7 learning outcomes)	3. To determine the strategic requirements for establishing the human resources management system. 4. To determine the work post systematisation in a company. 5. To determine the work evaluation system in a company.					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☐	Oral exam	☒
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☒	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Noe, R.A., Hollenbeck, J.R., Gerhart, B., Wright, P.M. (2006): Menadžment ljudskih potencijala, Mate, Zagreb, III izd.					
	McCourt, W., Eldridge, D. (2003): Global Human Resource Management, UK: Edward Elgar, Cheltenham					
4.2. Additional literature	Bahtjarević Šiber, F. (1999): Management ljudskih potencijala, Golden marketing, Zagreb					
	Možina, S. (2002): Managenet kadrovskih virov. Kranj, Fakulteta za organizacijske vede					

1. GENERAL DATA			
1.1. Name of the course	Risks of carcinogenic pollution in the wood industry	1.6. Course teacher(s)	Prof. Anka Ozana Čavlović, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	8 + 10 +6
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	Click or tap here to enter text.
1.4. No. of the course	93	1.9. ECTS credits	7
1.5. Code of the course	DDT 310	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
1.1. Course objectives	Acquisition of scientific knowledge from current research on the issue of carcinogenic pollutants in the wood industry, measures and techniques for protection against the risk of exposure to carcinogenic substances at work and harmful emissions of carcinogenic pollutants into the environment. Application of scientific knowledge for critical thinking and improvement of the application of legal regulations and the best available measures and techniques for reducing harmful emissions of carcinogenic substances into the working and general environment.		
1.2. Course contents (syllabus)	Problems of protection of the wood processing environment and safety at work in the wood industry from the point of view of the latest scientific knowledge on the risks of carcinogenic pollution. EU legal acts and national regulations on air protection and occupational safety related to carcinogenic substances in the wood industry. Research on occupational exposure to carcinogens in the workplace, health effects, risks and protection measures. Gravimetric and photometric method for determining the mass concentration of suspended particles in the workplace. Problems of carcinogenic substances that occur in wood processing processes (combustion in fireboxes, hydrothermomechanical wood processing, etc.), scientific knowledge of their impact on the environment, current regulatory measures and protection techniques. Selection of the best available techniques for purification of carcinogenic contaminants in wood technology and environmental protection plants.		
1.3. Expected learning outcomes at the level of	1. interpret, argued and on the basis of scientific research and legal regulations, the issue of occupational exposure to carcinogens at work in the wood industry;		

the course (4 to 7 learning outcomes)	2. propose and apply current legislation on air protection and occupational safety related to emissions risks in the wood industry; 3. apply an appropriate measuring method for determining the mass concentration of suspended particles in the working space; 4. interpret the results of determining the mass concentration of suspended particles and evaluate the level of exposure of workers; 5. apply measures and techniques to protect the environment from exposure to carcinogenic substances from production processes in the wood industry; 6. elect the best available techniques for the purification of carcinogenic pollutants generated in the wood industry processes.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☐	Research	☒	Oral exam	☐
	Experimental work	☐	Report	☒	**concultations**	☒
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Čavlović, A.O.: Zaštita industrijskog okoliša (Protection of industrial environment), revised teaching material, 2016.
	Briški, F.: Zaštita okoliša (Protection of the environment). Sveučilište u Zagrebu, Fakultet kemijskog inženjerstva i
	EU legal acts and national regulations.
	Pervan, S.: Tehnologija obrade drva vodenom parom (Steam wood treatment technology), Fakultet šumarstva i drvne
	Herceg, N: Okoliš i održivi razvoj (Environment and sustainable development), udžbenik, Synopsis, 2013
4.2. Additional literature	Kauppinen, T., et al., 2006: Occupational exposure to inhalable wood dust in the member states of the European Union,
	Ljubičić Čalušić, A., et al., 2013: Respiratory health and breath condensate acidity in sawmill workers," Int. Arch. Occup.
	Čavlović, A.O., Bešlić, I., 2021: Application of photometry in determining the dust mass concentration of hardwoods. Wood

	Čavlović, A.O., Bešlić, I., Zgorelec, Ž., Ožegović, J., 2021: Reliability of the Measurement Method in Determining the Mass
	Očkajová A., et al. (2020) Occupational Exposure to Dust Produced when Milling Thermally Modified Wood. Int. J. Environ.
	+ selected scientific articles

1. GENERAL DATA			
1.1. Name of the course	Life Cycle Assessmen in Forestry and Wood Industry šumarstvu i drvnoj industriji	1.6. Course teacher(s)	assist. prof. Andreja Đuka assist. prof. Andreja Pirc Barčić assist. prof. Kristina Kalrić
1.2. Name of the module (if applicable)	-	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/andreja-djuka/ https://www.sumfak.unizg.hr/en/about/general-information/staff/andreja-pirc-barcic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/kristina-klaric/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	10 + 6 + 8
1.4. No. of the course	94	1.9. ECTS credits	7
1.5. Code of the course	DDT 311	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to provide knowledge and understanding of environmental efficiency and environmental implications of products and services from raw materials through products to waste by applying the Life Cycle Assessment (LCA) methodology as parts needed to plan, manage and improve modern business processes in forestry and wood industry. Furthermore, the aim of the course is to enable students to gain knowledge regarding environmental performance of products and services throughout their life cycle in order to increase demand for more environmentally friendly products, services and technologies in forestry and wood industry aiming to help end-users to make informed decisions.		
2.2. Course contents (syllabus)	Introduction and historical overview of the 'Life Cycle Thinking' concept, the 'circular economy' concept, and the concept of 'cradle-to-cradle' in the context of obtaining wood raw materials and production of wood products . Introduction and historical overview of the Life Cycle Assessment (LCA) method. Advantages and disadvantages of conducting LCA analysis.		

	Introduction of standards and other relevant documents that define the methodology of implementation of the LCA procedure. Defining goals, scope, editing boundaries and specifics. Condition analysis (LCI - Life Cycle Inventory) using appropriate LCA software. Application of LCA in forestry - extraction of wood raw material. Application of LCA in the wood industry - production and use of wood products. Conducting a life cycle assessment analysis for a product or service in forestry and the wood industry.					
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. To analyze the 'life cycle thinking', concept, 'circular economy' concept and 'cradle - to - cradle' concept and critically interpret the advantages and challenges of application in practice in the field of forestry and wood industry 2. To connect scientific research findings and life cycle assessment application within forestry and wood industry 3. To understand the methodology and application of life cycle assessment in forestry and wood industry 4. To apply basic software knowledge and conduct LCA analysis of products or services within forestry and wood industry 5. To understand and interpret the key advantages and challenges of applying LCA in forestry and wood industry based on LCA analysis. 6. To contribute to the creation of new knowledge regarding LCA application in forestry and wood industry					
3. MONITORING AND EVALUATION OF STUDENT WORK						
3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Class attendance	☒	Research	☒	Oral exam	☐
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		
4. LITERATURE LIST						
4.1. Obligatory literature	Đuka, A., Vusić, D., Horvat, D., Šušnjar, M., Pandur, Z., Papa, I., 2017: LCA Studies in Forestry – Stagnation or Progress? Croatian journal of forest engineering 38 (2) 311–326.					

	Pirc Barčić, A. (2017): Boostering knowledge and information about the importance of the LCA analysis in wood environmental impact assessment of wooden products. 1-13, Univeristy of Primorska, Koper, Slovenia.
	Sahoo, K., Bergman, R., Alanya-Rosenbaum, S., Liang, S. (2019): Life Cycle Assessment of Forest-Based Products: A Review. Sustainability. 11, 4722; doi:10.3390/su11174722.
4.2. Additional literature	Heinimann, H.R. 2012: Life cycle assessment (LCA) in Forestry – State and Perspectives. CROJFE 33(2): 357–372.
	Bosner, A., Poršinsky, T., Stankić, I. 2012. Forestry and life cycle assessment. P. 139-160 in Global perspectives on sustainable forest management, C.A. Okia (Ed.). InTech, ISBN: 978-953-51-0569-5.

1. GENERAL DATA			
1.1. Name of the course	Sustainable development and eco-innovation on wood industry	1.6. Course teacher(s)	assist. prof. Andreja Pirc Barčić prof. Darko Motik assist. prof. Kristina Kalrić
1.2. Name of the module (if applicable)	-	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/andreja-pirc-barcic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/darko-motik/ https://www.sumfak.unizg.hr/en/about/general-information/staff/kristina-klaric/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	10 + 0 + 14
1.4. No. of the course	95	1.9. ECTS credits	7
1.5. Code of the course	DDT 312	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	The aim of the course is to provide knowledge in the field of sustainable development and eco-innovation as important segments in planning, managing and improving modern business processes in wood industry companies. Furthermore, the aim of the course is to enable students to acquire competencies for working in responsible positions of senior management in wood processing and furniture companies (e.g. research, analysis and application sustainable development concepts, improvement and development of eco-innovation, sustainable production and sustainable consumption of wood products) with a purpose company's sustainable business transactions and modernizing its business processes.		
2.2. Course contents (syllabus)	The role of sustainable production and sustainable consumption in wood industry development activities and wood products improvement. Analysis and implementation of strategies, documents, regulations and recommendations important for understanding sustainable development concept. The role of eco-innovation. Analysis of documents		

	necessary for eco-innovation application (products, processes, marketing and business) within wood industry companies. Linking sustainable development to modern business concepts of companies (e.g. circular economy; sharing economy, etc.). Management systems related to sustainable management. Accreditation, certification, system supervision. Certified sustainable management systems in the wood industry. Implementation of sustainable development principles to wood industry. The importance of eco-innovation as a basis for circular economy development within wood industry companies. The relationship between market and eco-innovation regarding wood processing and furniture production. Marketing, economic and technological aspects of eco-innovation in wood processing and furniture manufacturing companies. The role of eco-labels in promoting international policies for sustainable production and consumption of wood products. Recognizing and learning examples of sustainable wood industry in international wood and wood products market. Recognizing and learning examples of eco-innovation in international wood and wood products market.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. to analyze, interpret and critically reflect to the sustainable development concept 2. to connect scientific research findings with strategies, regulations and other relevant documents important for sustainable development concept application within wood industry companies 3. to research and interpret eco-innovation and its connection with the modernization of the company's business processes 4. to research and recommend examples of eco-innovations in domestic and international market of wood and wood products 5. to contribute to knowledge creation regarding eco-labeling models applicable to wood products

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes						
	Class attendance	☒	Research	☒	Oral exam	☐
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Željka Kordej-De Villa, Paul Stubbs, Marijana Sumpor: Participativno upravljanje za održivi razvoj. Ekonomski institut.
	Matešić, M. 2020.: Eko-inovacije za održivi razvoj. Socijalna ekologija, 29 (2). Zagreb.2020.
	Galović, T. 2016: uvod u inovativnost pdouzeća. Ekonomski fakultet Sveučilišta u Rijeci
4.2. Additional literature	Bačun, Dubravka; Matešić, Mirjana; Omazić, Mislav Ante: leksikon održivog razvoja. Hrvatski poslovni savjet za održivi

1. GENERAL DATA			
1.1. Name of the course	Innovative technologies in product design and development	1.6. Course teacher(s)	Prof. Silvana Prekrat, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/silvana-prekrat/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	10+8+6
1.4. No. of the course	96	1.9. ECTS credits	7
1.5. Code of the course	DDT 313	1.10. Language(s)	Croatian ☒ English ☒

2. COURSE DESCRIPTION	
2.1. Course objectives	Introduction to advanced CAD system and other innovative technologies in the process of designing furniture, wood products and furnishing facilities and their connection with industry 4.0. Training for achieving a more efficient development and production process with the application of innovative design technologies.
2.2. Course contents (syllabus)	Advanced CAD systems. Parameterization of 3D design. Product variability. Determining features in 3D modeling. Optimization with respect to the dimensions and shape of structural elements. Automation in design and construction. Generative design. Simulation modeling. Augmented and virtual reality in the presentation of products and interiors. Reverse engineering in product development.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. Describe and explain the application of innovative technologies in the design process. 2. Explain the application of reverse engineering in product development and innovation creation. 3. Select the optimal 3D modeling procedure. 4. Analyze the stages of design automation and evaluate their efficiency in product development, furniture production and furnishing. 5. Optimize structural elements and assemblies in one of the available CAD programs.

3. MONITORING AND EVALUATION OF STUDENT WORK						
	Class attendance	☐	Research	☐	Oral exam	☐

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes	Experimental work	☐	Report	☐	**Published article in a scientific journal**	☒
	Essay	☐	Seminar paper	☒	**Presentation of seminar paper**	☒
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST	
4.1. Obligatory literature	Pandžić, I.S., i surdnici: (2011) Interaktivna 3D grafika i njene primjene, Element
	Smardzewsky, J. (2016): Furniture design, Springer
	Bryden, D.: (2014.) CAD and rapid prototyping for product design
	Vukašinović, N., Duhovnik, J. (2018.): Advanced CAD Modeling, 2018, Springer
	Lindemann, U. (2016): Handbuch Produktentwicklung
	Chen, J.Y.C., Fragomeni, G. (2020): Virtual, Augmented and Mixed Reality, Springer
4.2. Additional literature	Schodek, D. I suradnici: (2004.) Digital Design and Manufacturing: CAD/CAM Applications in Architecture and Design, Wiley
	Ehrlenspiel, K. i suradnici (2017.): Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit
	Bianconi, F., Filippucci, M. (2019.): Digital Wood Design, Springer
	Baros, M.P., Chaparro B.M. (2020) The digital design process in furniture industry:Towards a new dialog between designer, user and producer
	Wiberg, A. (2019.):Towards Design Automation for Additive Manufacturing, Linköping University
	Kragl, L. (2021): Implementing industriy 4.0 In Furniture factories
	Morenilla, A.J. (2021): Technology enablers for the implementation of Industry 4.0 to traditional manufacturing sectors
	Scurtu, L.I., Bodi, S., Dragomir, M.: (2015.): Optimization methods applied in cad based furniture design

1. GENERAL DATA			
1.1. Name of the course	Nanocellulose: synthesis, properties and application	1.6. Course teacher(s)	Assist. Prof. Nikola Španić, PhD Prof. Vladimir Jambreković, PhD
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/nikola-spanic/ https://www.sumfak.unizg.hr/en/about/general-information/staff/vladimir-jambrekovic/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	15 + 15 + 5
1.4. No. of the course	97	1.9. ECTS credits	7
1.5. Code of the course	DDT 314	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) to acquaint students with the historical development and reasons for the development of the nanocellulose preparation process 2) to explain the dependence of the share and distribution of cellulose, lignin and hemicelluloses in the structure of the lignocellulosic raw material on the efficiency of the nanocellulose preparation process 3) to define the laws of specific preparation procedures and their impact on the properties of nanocellulose 4) to explain the options of nanocellulose application in advanced (composite) materials systems 5) to train students for analytical determination of properties of nanocellulose and composites made using nanocellulose		

2.2. Course contents (syllabus)	Historical development of nanocellulose. The current state of nanocellulose as an industrial product. Ratio of chemical building blocks of wood. Fibrils. Hemicellulose and lignin. Linking the chemical composition with the extraction of nanocellulose by mechanical and chemical processes. Nanocellulose types. The influence of the preparation method on nanocellulose properties. Morphology of nanocellulose particles depending on preparation method. Dispersibility in solutions. Nanocellulose characterization. Spectroscopy. Microscopy. SEM. TEM. Colloidal properties and self-orientation of nanoparticles. Application of nanocellulose for composite materials. Hydro and aero gels. Use of nanocellulose in biomedicine. Nanocellulose-based electroactive materials. Emulsions. Challenges and limitations of the spread of nanocellulose application.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1) to identify the processes of nanocellulose preparation from wood and other lignocellulosic raw materials 2) to valorise the products of different nanocellulose preparation processes 3) to select methods for nanocellulose characterization 4) to identify potential directions of nanocellulose development and application 5) to describe the possibilities and to identify the limitations of the application of nanocellulose in modern composite materials

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes						
	Class attendance	☒	Research	☐	Oral exam	☐
	Experimental work	☐	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☒	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☒	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Huang, J., Dufresne, A.;, Lin, N. 2019: Nanocellulose: From Fundamentals to Advanced Materials. Wiley-VCH, SAD.

	Jawaid, M., Boufi, S., Abdul Khalil, H.P.S. 2017: Cellulose-Reinforced Nanofibre Composites - Production, Properties and Applications. Woodhead Publishing, Elsevier Ltd., Duxford, UK.
	Kalia, S., Kaith, B.S., Kaur, I. 2011: Cellulose Fibers: Bio- and Nano- Polymer Composites (Green Chemistry and Technology). Springer-Verlag, Berlin Heidelberg.
	Oksman, K., Sain, M. 2006: Cellulose Nanocomposites - Processing, Characterization, and Properties. American Chemical Society, SAD
4.2. Additional literature	Selected scientific papers

1. GENERAL DATA			
1.1. Name of the course	Evaluation of CNC technology in wood processing	1.6. Course teacher(s)	Associate prof. Goran Mihulja, PhD.
1.2. Name of the module (if applicable)	Click or tap here to enter text.	1.7. Link(s) to CV of teacher(s)	https://www.sumfak.unizg.hr/en/about/general-information/staff/goran-mihulja/
1.3. Status of the course	compulsory course	1.8. Structure of teaching (number of hours: L + E + S)	15 + 20 + 0
1.4. No. of the course	98	1.9. ECTS credits	7
1.5. Code of the course	DDT 315	1.10. Language(s)	Croatian ☒ English ☒
2. COURSE DESCRIPTION			
2.1. Course objectives	1) give students an introduction and overview of the basic theoretical settings of CNC technology, the most important elements and basic divisions. 2) show students the breadth of factors that affect the results of the application of CNC technology in wood industry production and their application in qualitative analysis in scientific research, 3) to enable students to conduct basic qualitative analyzes of their own research results as well as the results of other researchers in the field of application of computer numerically controlled wood processing technology, 4) to enable students to independently think about the use of computer numerically controlled technology in wood processing of its values and limitations in modern production systems.		
2.2. Course contents (syllabus)	Theory of computer numerically controlled wood processing technology. Divisions and the most important elements of technology. Processing definition and control software and its importance in technology. Analysis of individual processing technologies, processing strategies, types and models of application software for preparation / planning of wood and other materials processing in the production of furniture and other wood products. Workpiece fastening systems. Stress and deformation relations of workpieces during machining with regard to the types and shapes of workpiece fastening units and determination of their influence on machining accuracy. Optimization of the sequence of element machining operations with regard to the occurrence of the load on the workpiece fastening system and the influence on the speed and quality of machining.		

	Analyzes of the influence of vibrations, stresses, material deformations and impact loads of tools in machining on the quality and accuracy of machining by different cnc machines and the use of different types of fastenings. Analyzes of the influence of machining parameters with regard on tool type, machining quality and production time consumption.
2.3. Expected learning outcomes at the level of the course (4 to 7 learning outcomes)	1. to create and critically evaluate new scientific facts and findings in the field of research of CNC technology in wood processing 2. analyze, interpret, critically reflect on new research problems in the field of CNC technology in wood processing 3. independently scientifically research in the way of moving the boundaries of existing knowledge in the field of CNC technology in wood processing and contribute to the creation of new knowledge 4. evaluate and improve the processes of CNC technology in wood processing 5. to express oneself through scientific papers written according to scientific and professional standards 6. develop new ideas or processes, and responsibility for the success of research, the social usefulness of the results, and awareness of their possible negative consequences.

3. MONITORING AND EVALUATION OF STUDENT WORK

3.1. Elements of the student work monitoring and the evaluation of achieved learning outcomes						
	Class attendance	☐	Research	☒	Oral exam	☒
	Experimental work	☒	Report	☐	Click or tap here to enter text.	☐
	Essay	☐	Seminar paper	☐	Click or tap here to enter text.	☐
	Preliminary exam	☐	Practical work	☐	Click or tap here to enter text.	☐
	Project	☐	Written exam	☐		

4. LITERATURE LIST

4.1. Obligatory literature	Click or tap here to enter text.
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4.2. Additional literature	Click or tap here to enter text.
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