

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Les in lignocelulozni materiali za uporabo v gradbeništvu
Course title:	Wood and lignocellulosic materials for building applications

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	Les in biokompoziti	1,2	1,2,3,4
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	Wood and biocomposites	1,2	1,2,3,4

Vrsta predmeta / Course type teoretični predmet / theoretical course

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
20	15	40	/	15	160	10

Nosilec predmeta / Lecturer: Nosilec: prof. dr. Miha Humar

Jeziki / Languages:	Predavanja / Lectures:	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: **Prerequisites:**

Splošni pogoji za vpis na doktorski študij

General conditions for enrollment in doctoral study

Vsebina: **Content (Syllabus outline):**

Les in ostali lignocelulozni materiali so vsakodnevno izpostavljeni biotskim in abiotskim dejavnikom razkroja. Orisani bodo biotski dejavniki razkroja, v prvi vrsti lesne glive. V nadaljevanju bodo predstavljene novejšje biocidne in nebiocidne tehnike zaščite lesa. Velik poudarek bo na modifikaciji lesa (fizikalno kemijskimi, pasivnimi kemijskimi, aktivnimi kemijskimi in površinskimi modifikacijami), zaščiti lesa s hidrofobnimi sistemi (voski, emulzijami voskov, olji, silani, siloksani...) in ustrezni izbiri in uporabi lesnih vrst. Študentom predstavimo pomen vode in sorpcijskih lastnosti lesa za delovanje gliv in metodami za določanje vodoodbojnih lastnosti lesa. Slušatelje bomo seznanili z metodami za vrednotenje življenjske dobe lesa in lesnih kompozitov, vplivom klime na življenjsko dobo in metodami za njeno vrednotenje. Opisali bomo model odmerik-odziv, in ga uporabili na praktičnem primeru.

Študent se seznanja s pomenom in vlogo različnih lesnih kompozitov v konstrukcijah, pri čemer bo vloga kompozitov razdeljena v pet sklopov in sicer sorpcijski, mehanski, izolativni (toplotni in akustični), ognjeodpornost in fasadni sistemi. Pri vseh sklopih se bodo študenti seznanili z zakonitostmi obnašanja materiala, še posebej pri vzajemnem delovanju več mehanizmov v daljšem časovnem obdobju, pri čemer bomo z različnimi matemtičnimi modeli predvideli obnašanje lesnih kompozitov in ohranjanje njihove osnovne funkcije v konstrukciji. Poudarjeni bodo tudi kritični pogoji za porušitev, spremembo lastnosti zaradi spremembe vlažnosti, razvoj mikroorganizmov, plesni, itd. Študenti se podrobno seznanijo z možnostjo uporabe različnih nano biomaterialov kot sistemov izboljšanja lastnosti lesnih ploščnih kompozitov. Seznanijo se z vlogo kompozitov pri zagotavljanju zdravega bivalnega okolja. Predstavili bomo tudi možnost recikliranja lesa in lesnih kompozitov iz starih (porušeni) objektov. Študenti spoznajo tudi spreminjanje lastnosti lesnih kompozitov v daljšem časovnem obdobju, možnosti napovedovanja obnašanja kompozitov in sodobne nedestruktivne postopke ugotavljanja spreminjanja lastnosti kompozitov.

Staranje lignocelulozних materialov, lesnih

Wood and other lignocellulosic materials are daily exposed to biotic and abiotic factors of degradation. Biotic degradation, primarily wood decay fungi will be elucidated. In the next step biocidal and non-biocidal techniques for wood protection will be outlined. Great emphasis will be on the modification of wood (physico-chemical, chemical passive and active and chemical surface modifications), the protection of wood with hydrophobic systems (waxes, wax emulsions, oils, silanes, siloxanes ...) and the appropriate selection and use of wood species. Students learn the importance of water and sorption properties for the fungal growth and development and methods for determination of the water exclusion efficacy. Attendees will learn about methods for evaluating the service life of the wood and wooden materials, the influence of climate on life expectancy and methods for its estimation. We will describe the dose-response model, and apply it on the practical example.

Students are going to learn the significance and role of different wood based composites in construction, whereby their role is going to be divided into five segments; sorption, mechanical insulation (thermal and acoustic), fire resistance and façade system. In all cases students are going to learn the behaviour of material due multiple effect of different factors, whereby they are going to get familiar with different predictional models for the behaviour of wood based composites for retaining their basic function in construction. The emphasize is going to be focused on critical conditions for load failure of construction, degradation of properties due change in moisture, development of different microorganisms and mould, etc. They are also going to learn about the possibility for improvement of different properties by use of different nano biomaterials. Students will also learn about the impact of wood based composites on the living environment. Some possibilities of recycling of wood and wood based composites from old (demolished) objects are going to be presented. Students will learn properties development (changes) of wood based composites during their usage (long term behaviour), prediction possibilities and non-destructive test methods for the tracking of composites properties.

kompozitov in lesa zaradi izpostavitve vremenskim vplivom (ponovitev osnov). Podrobnejši prikaz fotodegradacijskih procesov v lignoceluloznih materialih ter kratek pregled najprimernejših tehnik za raziskave fotodegradacijskih procesov (SEM, FT-IR in EPR). Sodobni zaščitni premazi. Novosti pri razvoju UV absorberjev, lovilcev prostih radikalov in nanodelcev za zaščito podlage in premaza. Superhidrofobne površine. Samočistilne površine. Nanodelci TiO₂ za zaščito pred UV svetlobo (rutil); fotokatalitsko delovanje TiO₂ v samočistilnih površinah (anataz).

Weathering of lignocellulosic materials, wood-based composites and of wood (recapitulation of some basic information). Detailed survey of photodegradation processes in lignocellulosic materials and a short overview of the most appropriate experimental techniques to follow these processes (SEM; FT-IR, EPR). Contemporary protective exterior coatings. Novelty in development of UV absorbers, free radical scavengers and nanoparticles for protection of a substrate and of a surface finish. Superhydrophobic surfaces. Self-cleaning surfaces. TiO₂ nanoparticles for protection against UV light (rutile); photocatalytic activity of TiO₂ in self-cleaning surfaces (anatase).

Temeljni literatura in viri / Readings:

1. NAVODNIK, J. Slovenija je ustvarjena za nanotehnologije: izdelki in tehnologije prihodnosti: strokovna monografija. Celje: Navodnik, 2007. 399 str. ISBN 978-961-92027-0-8. (izbrana poglavja)
2. BULIAN, F., GRAYSTONE. J. Wood coatings : theory and practice. Amsterdam: Elsevier, 2009. 320 str. ISBN 978-0-444-52840-7. (izbrana poglavja)
3. Goodell B., Darrel, D.N., Schultz, T.P., 2003. Wood Deterioration and Preservation – Advances in Our Changing World. American Chemical Society, Washington, DC: 465 str., ISBN 0-8412-3797
4. MacKenzie, C E, Wang, C-H, Leicester, R H, Foliente, G C, Nguyen, M N, 2007. Timber service life design guide. Forest & Wood Products Australia Limited, Victoria ISBN 978-1-920883-16-4
5. Mizi, F. Et al., 2009: Performance in use and new products of wood based composites. London, Brunel University Press

Študentom bo na razpolago tudi gradivo s predavanj in vaj v elektronski obliki. Gradivo bo objavljeno pred začetkom predavanj na spletni strani. Za izdelavo seminarskih nalog in dodatno razumevanje vsebin bodo študentje uporabili tudi svetovni splet (internet).

Cilji in kompetence:

Cilj predmeta:

Spoznati pomen in delovanje biotskih dejavnikov razgradnje. To bo omogočilo razumevanje delovanje biocidnih in nebiocidnih oblik zaščite lesa in podobnih materialov. Slušatelj razumejo in poznajo pomen vode v lesu za delovanje gliv in poznajo tehnične rešitve kako ohraniti les suh. Poznavanje lastnosti materialov in osnov fiziologije gliv omogoča načrtovanje in vrednotenje življenjske dobe lesa.

Spoznati in razumeti vlogo lesnih kompozitov v konstrukcija. Študent razume procese staranja kompozitov in posledice staranja na lastnosti kompozitov. Student spozna in razume različne sisteme napovedovanja obnašanja kompozitov v daljšem časovnem obdobju.

Objectives and competences:

Objectives: to recognize the importance and mechanisms of the biotic factors of degradation. This will enable understanding of the mode of action of the biocidal and non-biocidal methods for protection of wood and similar materials. Students understand and recognize the importance of water in the wood for the fungal development and understand technical solutions how to keep the wood dry. Understanding of the materials and basic physiology of fungi enables the design and evaluation of the service life of the wood. Students will learn and understand the role of wood based composites in construction. They understand the ageing process on the properties of wood based composites. Students will learn and understand different prediction

Spozna možnosti uporabe različnih biomaterialov kot sistemov izboljšanja lastnosti. Seznanen se z metodami spremljanja lastnosti že vgrajenih kompozitov.

Spoznati in razumeti fotodegradacijske procese lignoceluloznih materialov in tehnik za spremljanje le-teh. Študent spozna novosti pri razvoju UV zaščitnih snovi, s poudarkom na uporabi nanodelcev v zaščiti lesa pred abiotičnimi dejavniki razkroja. Spozna superhidrofobne in samočistilne površine ter razume, kako je možno doseči efekta superhidrofobnosti in samočistilnosti. Prav tako spozna pomen rutilne oblike nanodelcev TiO_2 za zaščito pred UV svetlobo ter TiO_2 v obliki anataza v samočistilnih površinah.

Kompetence:

Doseženo znanje slušatelju omogoči obvladati najpomembnejše nove materiale oz. jih optimalno izbrati, za zaščito lignoceluloznih materialov, ki so v različnih konstrukcijah ter objektih izpostavljeni biotskim in vremenskim vplivom.

Pridobljeno znanje omogoči študenti izbrati ustrezen kompozit glede na obremenitev in namen uporabe z vidika željene trajnosti objekta, ter spremljanja obnašanja materiala v konstrukciji.

systems of behaviour of composites in longer time of use. They learn about the possibility of use of different biomaterials as reinforcement for wood based composites. Students will also learn about the different methods for tracking of properties of installed(used) composites.

Students learn and understand photodegradation processes of lignocellulosic materials and experimental techniques to follow these processes. A student learns new findings in development of UV protective compounds, with a focus on applications of nanoparticles in protection of wood against weathering. He/she learns superhydrophobic and self-cleaning surfaces and understands how to achieve superhydrophobic and self-cleaning effects. In addition, he/she gets known with rutile TiO_2 nanoparticles for UV protection and in TiO_2 the form of anatase for self-cleaning surfaces.

Competences:

The acquired knowledge allows a participant to understand the most important novel weathering-protective materials and to be capable to make the most optimal selection of contemporary protective means for lignocellulosic materials in various constructions and objects that are exposed to weathering and biotic factors of the decay.

Gain knowledge will enable the student to select appropriate composite with regard to the load/exposure from the aspect of wished service lifetime and to track the behaviour of material in construction.

Predvideni študijski rezultati:

Znanje in razumevanje:

Znanje in razumevanje:

Študent pozna mehanizme glivne razgradnje lesa, pomen vode v lesu. Seznanjen je z najpomembnejšimi biocidnimi in nebiocidnimi rešitvami za zaščito lesa, njihovimi prednostmi in omejitvami. Za posamezen namen uporabe zna izbrati ustrezno lesno vrsto, postopek zaščite in način uporabe.

Spoznati in razumeti vlogo lesnih kompozitov v konstrukcija. Študent razume procese staranja kompozitov in posledice staranja na lastnosti kompozitov. Študent spozna in razume različne sisteme napovedovanja obnašanja kompozitov v daljšem časovnem obdobju. Spozna možnosti uporabe različnih biomaterialov kot sistemov izboljšanja lastnosti. Seznanen se z

Intended learning outcomes:

Knowledge and understanding:

Knowledge and understanding:

Students understands the mode of fungal degradation and the importance of water in wood. They are familiar with different techniques for wood protection, their advantages in disadvantages. They understand how to select proper wood species, proper treatment and design its use for various building applications.

Students will learn and understand the role of wood based composites in construction. They understand the ageing process on the properties of wood based composites. Students will learn and understand different prediction systems of behaviour of composites in longer time of use. They learn about the possibility of

metodami spremljanja lastnosti že vgrajenih kompozitov.

Študent pozna in razume procese fotodegradacije lignoceluloznih materialov. Pozna najnovije materiale za zaščito lignoceluloznih materialov in premazov pred vremenskimi vplivi. Pozna in razume pomen superhidrofobnih in samočistilnih površin za zaščito lesenih / lignoceluloznih elementov v različnih konstrukcijah in objektih, ki so izpostavljeni vremenskimi vplivom.

Refleksija: predmet predstavlja strokovni temelj v skladu z naravo študija in je zelo dobra podlaga za nadaljnje proučevanje lastnosti obdelanih materialov in površin ter sodobnih materialov in postopkov površinske obdelave lesa.

Prenosljive spretnosti: študent pridobljeno znanje uporablja pri drugih tehnoloških predmetih. Zna uporabiti domačo in tujo literaturo ter računalniške baze podatkov. Poleg tega obvlada osnove znanstveno raziskovalnega dela (postavitev hipoteze na osnovi svojega znanja in literaturnih podatkov, načrt eksperimenta, razprava in ovrednotenje rezultatov).

use of different biomaterials as reinforcement for wood based composites. Students will also learn about the different methods for tracking of properties of installed (used) composites.

A student knows and understands photodegradation processes of lignocellulosic materials. He/she knows contemporary materials for protection of lignocellulosic materials and surface coatings for their protection against weathering. He/she is acquainted with and understands the meaning of superhydrophobic and self-cleaning surfaces for protection of lignocellulosic elements in various constructions and objects that are exposed to weathering.

Reflections: the course is the professional fundament in accordance with the nature of the study. It represents a firm basis for further studies of properties of treated materials and surfaces and of contemporary materials and surface treatment processes.

Transferable skills: a student can use the knowledge at other technological courses. He/she knows to use scientific literature and computer data bases. Besides, he/she is acquainted with methods of scientific research work (can make a hypothesis, experimental plan, discussion, critical evaluation of the results).

Metode poučevanja in učenja:

Predavanja (20 ur),
Seminarji (15 ur),
Laboratorijske vaje (40 ur),
Ostalo (15 ur)

Learning and teaching methods:

Lectures (20 h)
Seminar (15 h)
Laboratory work (40 h)
Other (15 h)

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Pisni in ustni izpit	60%	Oral and written exam
Seminar	40%	Seminar

Reference nosilca – izvajalca / Lecturer's references:

Miha Humar

1. HUMAR, Miha. Influence of Norway spruce and European larch Heartwood ring-width on extractive content and durability, *Drvena industrija*, ISSN 0012-6772, 2013, vol. 64, no. 2, str. 79-85.
2. HUMAR, Miha, LESAR, Boštjan. Efficacy of linseed- and tung-oil-treated wood against wood-decay fungi and water uptake. *International biodeterioration & biodegradation*, ISSN 0964-8305. [Print ed.], 2013, vol. 85, str. 223-227.
3. THALER, Nejc, HUMAR, Miha. Performance of oak, beech and spruce beams after more than 100 years in service. *International biodeterioration & biodegradation*, ISSN 0964-8305. [Print ed.], 2013, vol. 85, str. 305-310.
4. LESAR, Boštjan, HUMAR, Miha, KAMKE, Frederick A., KUTNAR, Andreja. Influence of the thermo-hydro-mechanical treatments of wood on the performance against wood-degrading fungi. *Wood Science and Technology*, ISSN 0043-7719, 2013, vol. 47, iss. 5, str. 977-992
5. LESAR, Boštjan, HUMAR, Miha. Use of wax emulsions for improvement of wood durability and sorption properties. *Holz als Roh- und Werkstoff*, ISSN 0018-3768. [Print ed.], 2011, vol. 69, no.2, str. 231-238.
6. LESAR, Boštjan, STRAŽE, Aleš, HUMAR, Miha. Sorption properties of wood impregnated with aqueous solution of boric acid and montan wax emulsion. *Journal of applied polymer science*, ISSN 0021-8995, 2011, vol. 120, no. 3, str. 1337-1345.
7. LESAR, Boštjan, UGOVŠEK, Aleš, KARIŽ, Mirko, ŠERNEK, Milan, HUMAR, Miha, KRALJ, Polonca. Influence of boron compounds in adhesives on the bonding quality and fungicidal properties of wood. *Wood research*, ISSN 1336-4561, 2011, vol. 56, no. 3, str. 385-392.
8. LESAR, Boštjan, GORIŠEK, Željko, HUMAR, Miha. Sorption properties of wood impregnated with boron compounds, sodium chloride and glucose. *Drying technology*, ISSN 0737-3937, 2009, vol. 27, no. 1, str. 94-102.
9. HUMAR, Miha, LESAR, Boštjan. Influence of dipping time on uptake of preservative solution, adsorption, penetration and fixation of copper-ethanolamine based wood preservatives. *Holz als Roh- und Werkstoff*, ISSN 0018-3768. [Print ed.], 2009, vol. 67, no. 3, str. 265-270.
10. LESAR, Boštjan, KRALJ, Polonca, HUMAR, Miha. Montan wax improves performance of boron-based wood preservatives. *International biodeterioration & biodegradation*, ISSN 0964-8305. [Print ed.], 2009, vol. 63, no. 3, str. 306-310.

Marko Petrič

1. KUTNAR, Andreja, KRIČEJ, Borut, PAVLIČ, Matjaž, PETRIČ, Marko. Influence of treatment temperature on wettability of Norway spruce thermally modified in vacuum. *Journal of adhesion science and technology*, ISSN 0169-4243, 2013, vol. 27, no. 9, str. 963-972
2. HRASTNIK, David, BUDIJA, Franc, HUMAR, Miha, PETRIČ, Marko. Influence of liquefied and ccb containing liquefied wood on growth of wood decay fungi. *Maderas. Ciencia y tecnología*, ISSN 0717-3644, 2013, vol. 15, no. 1, str. 105-118.
3. YONA, Arnaud Maxime Cheumani, PORI, Pavel, KRIČEJ, Borut, KUTNAR,

Andreja, BUDIJA, Franc, TAVZES, Črtomir, PETRIČ, Marko. Bleaching of liquefied wood for the preparation of aesthetically manageable biomaterials. Journal of biobased materials and bioenergy, ISSN 1556-6560, 2012, vol. 6, no. 5, str. 601-607.

4. LESAR, Boštjan, PAVLIČ, Matjaž, PETRIČ, Marko, SEVER ŠKAPIN, Andrijana, HUMAR, Miha. Wax treatment of wood slows photodegradation. Polymer degradation and stability, ISSN 0141-3910, 2011, vol. 96, no. 7, str. 1271-1278.
5. HUMAR, Miha, PAVLIČ, Matjaž, ŽLINDRA, Daniel, TOMAŽIČ, Miro, PETRIČ, Marko. Performance of waterborne acrylic surface coatings on wood impregnated with Cu-ethanolamine preservatives. Bulletin of Materials Science, ISSN 0250-4707, 2011, vol. 34, no. 1, str. 113-119.
6. BUDIJA, Franc, TAVZES, Črtomir, ZUPANČIČ-KRALJ, Lucija, PETRIČ, Marko. Self-crosslinking and film formation ability of liquefied black poplar. Bioresource technology, ISSN 0960-8524. [Print ed.], 2009, vol. 100, no. 13, str. 3316-3323.

Sergej Medved

1. RAUTKARI, Lauri, LAINE, Kristiina, KUTNAR, Andreja, MEDVED, Sergej, HUGHES, Mark. Hardness and density profile of surface densified and thermally modified Scots pine in relation to degree of densification. Journal of Materials Science, ISSN 0022-2461, 2013, vol. 48, no. 6, str. 2370-2375
2. MEDVED, Sergej, JAMBREKOVIĆ, Vladimir, ANTONOVIĆ, Alan. Impact of resin content on swelling pressure of three layer particleboard bonded with urea-formaldehyde adhesive. Drvna industrija, ISSN 0012-6772, 2011, vol. 62, br. 1, str. 37-42.
3. KUNAVER, Matjaž, MEDVED, Sergej, ČUK, Nataša, JASIUKAITYTE, Edita, POLJANŠEK, Ida, STRNAD, Tatjana. Application of liquefied wood as a new particle board adhesive system. Bioresource technology, ISSN 0960-8524. [Print ed.], 2010, vol. 101, no. 4, str. 1361-1368.
4. ANTONOVIĆ, Alan, JAMBREKOVIĆ, Vladimir, ŠPANIĆ, Nikola, KLJAK, Jaroslav, MEDVED, Sergej. Influence of urea-formaldehyde resin modification with liquefied wood on particleboard properties. Drvna industrija, ISSN 0012-6772, 2010, vol. 61, no. 1, str. 5-14.
5. KANDELBAUER, Andreas, PETEK, Primož, MEDVED, Sergej, PIZZI, Antonio, TEISCHINGER, Alfred. On the performance of a melamine-urea-formaldehyde resin for decorative paper coatings. Holz als Roh- und Werkstoff, ISSN 0018-3768. [Print ed.], 2010, let. 68, št. 1, str. 63-75.
6. MEDVED, Sergej, RESNIK, Jože. Determination of share of adhesive on particles with FT-IR spectroscopy. Wood research, ISSN 1336-4561, 2010, let. 55, št. 1, str. 101-109.

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Les, skorja in klima
Course title:	Wood, bark and climate

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	Les in biokompoziti	1,2	1,2,3,4
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	Wood and biocomposites	1,2	1,2,3,4

Vrsta predmeta / Course type teoretični predmet / theoretical course

Univerzitetna koda predmeta / University course code: Pustite prazno

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
10	15	15	/	5	80 ur	5

Nosilec predmeta / Lecturer: Nosilec: prof. dr. Katarina Čufar

Jeziki / Languages:	Predavanja / Lectures:	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: **Prerequisites:**

Splošni pogoji za vpis na doktorski študij.

General requirements for enrolment in doctoral study.

Vsebina: _____

Content (Syllabus outline): _____

Predmet obravnava les in skorjo dreves z vidika tkiv, ki nastanejo z delovanjem kambija pod vplivom notranjih in zunanjih dejavnikov. Naštevamo tematike. Kambij kot meristemsko tkivo dreves, delovanje kambija, delitve celic, nastanek sekundarnega ksilema in floema. Sezonska dinamika nastajanja tkiv pri iglavcih in listavcih v zmerni, hladni (borealni) in sredozemski klimi. Modeli dinamike nastajanja lesa. Vpliv zunanjih dejavnikov na dinamiko nastajanja lesa in floema in preživetvene strategije dreves tudi z vidika klimatskih sprememb. Metode za spremljanje delovanja kambija v odraslih drevesih in tehnike priprave mikroskopskih preparatov. Specifična uporaba mikroskopskih tehnik: svetlobna mikroskopija, transmisijska elektronske mikroskopija, UV-mikrospektrofotometrija. Dendrokronologija - branike v lesu kot arhiv, analiza branik in rekonstrukcija preteklih dejavnikov. Les kot tkivo v drevesu, kot material za predelavo in obdelavo ter v kulturni dediščini z vidika zgradbe in dendrokronologije. Baze klimatskih in fenoloških podatkov in njihova uporaba za proučevanje vpliva klime na nastajanje lesa. Les in rekonstrukcija klime. Paleoklimatski viri podatkov in metode njihove obdelave. Vzroki za variabilnost podnebja in fenološkega razvoja v različnih časovnih (desetletje, stoletja, tisočletje) in prostorskih (lokalna, regionalna, globalna) skalah.

The course deals with wood and bark as tissues formed by the cambium under the influence of internal and external factors. The topics: cambium as a meristem, its function, cell division, formation of secondary xylem and phloem. Seasonal dynamics of wood and phloem formation in conifers and dicotyledon trees in temperate, cold (boreal) and Mediterranean climate. Models of dynamics of wood formation. Influence of external factors on dynamics of wood and phloem formation and survival strategies of trees in terms of climate change. Methods for monitoring of process in the cambium in adult trees and techniques of tissue preparation. Specific use of microscopic techniques: light microscopy, transmission electron microscopy, UV-microspectrophotometry. Dendrochronology, tree-rings as an archive, tree-ring analysis and reconstruction of historical events. Wood as a tree tissue, raw material and wood in cultural heritage – from the perspective of wood structure and dendrochronology. Bases of climatic and phenological data and their use for studying the impact of climate on wood production. Wood reconstruction of climate. Paleoclimatic data sources and methods of their processing. Sources of variability of the climate and phenological development in different time (decade, century and millennium) and spatial (local, regional, global) scales.

Temeljni literatura in viri / Readings:

Fromm, J. (ur.) 2013. Cellular aspects of wood formation. Plant, Cell, Monographs, Springer, Berlin-Heidelberg, 260 str.

Schweingruber, F. H. 2007. Wood Structure and environment. Springer Series in Wood Science, Springer, Berlin-Heidelberg, 279 str.

Vaganov, E.A., Huggens, M.K., Shashkin A.V. 2006. Growth dynamics of conifer tree rings. Images of past and future environments. Springer, 354 str.

revijalni članki s področja,
tekoča periodika,
druga učna gradiva

Cilji in kompetence:

Objectives and competences:

Poznavanje lesa in skorje, z vidika notranjih in okoljskih dejavnikov med procesom nastajanja.

Knowledge on wood and bark, in terms of internal and environmental factors during the process of their formation.

Predvideni študijski rezultati:

Znanje in razumevanje:
Poznavanje zgradbe lesa in skorje, z vidika procesov med nastajanjem in vpliva okoljskih dejavnikov na procese.

Razumevanje, kako obravnavani dejavniki vplivajo na zgradbo, ter možnost uporabe lesa in skorje z ekološkega, tehnološkega in družbeno-ekonomskega vidika.

Intended learning outcomes:

Knowledge and understanding:
Knowledge of the wood and bark structure, in terms of processes during their formation and impact of environmental factors.

Understanding how these factors influence the structure and affect wood and bark use from an ecological, technological and socio-economic point of view.

Metode poučevanja in učenja:

Interaktivna predavanja in razlage, konzultacije, vaje, seminar.

Learning and teaching methods:

Interactive lectures and explanations, tutorials, seminars.

Načini ocenjevanja:

Izdelava in zagovor seminarja.

Delež (v %) /
Weight (in %)

Assessment:

Seminar work and its presentation.

100

Reference nosilca / izvajalcev / Lecturer's references:

Prof. dr. Katarina Čufar

1. PRISLAN, Peter, GRIČAR, Jožica, DE LUIS, Martin, SMITH, Kevin T., ČUFAR, Katarina. Phenological variation in xylem and phloem formation in *Fagus sylvatica* from two contrasting sites. *Agricultural and forest meteorology*, ISSN 0168-1923. [Print ed.], 2013, vol. 180, no. oct., str. 142-151. [COBISS.SI-ID 2115465], [JCR, SNIP, Scopus do 19. 11. 2013: št. citatov (TC): 0, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0, normirano št. čistih citatov (NC): 0] kategorija: 1A1 (Z1, A", A', A1/2); uvrstitev: SCI, Scopus, MBP; tipologijo je verificiral OSICB točke: 34, št. avtorjev: 5

2. ČUFAR, Katarina, GRABNER, Michael, MORGÓS, András, MARTINEZ DEL CASTILLO, Eurne, MERELA, Maks, DE LUIS, Martin. Common climatic signals affecting oak tree-ring growth

- in SE Central Europe. *Trees*, ISSN 0931-1890, 2014, str. [v tisku], ilustr.
<http://link.springer.com/article/10.1007%2Fs00468-013-0972-z>, doi: [10.1007/s00468-013-0972-z](https://doi.org/10.1007/s00468-013-0972-z).
 [COBISS.SI-ID [2171785](#)], [JCR, SNIP]
 kategorija: 1A1 (Z1, A', A1/2); uvrstitev: SCI, Scopus, MBP; tipologija ni verificirana
 točke: 15.92, št. avtorjev: 7
- 3.** NOVAK, Klemen, DE LUIS, Martin, RAVENTÓS BONVEHI, Jose, ČUFAR, Katarina. Climatic signals in tree-ring widths and wood structure of *Pinus halepensis* in contrasted environmental conditions. *Trees*, ISSN 0931-1890, 2013, vol. 27, no. 27, str. 927-936.
http://download.springer.com/static/pdf/467/art%253A10.1007%252Fs00468-013-0845-5.pdf?auth66=1360847080_64eb6ab909d59096228c966dfc0f1519&ext=.pdf. [COBISS.SI-ID [2088841](#)], [JCR, SNIP, WoS do 19. 9. 2013: št. citatov (TC): 0, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0, normirano št. čistih citatov (NC): 0, Scopus do 8. 8. 2013: št. citatov (TC): 0, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0, normirano št. čistih citatov (NC): 0]
 kategorija: 1A1 (Z1, A', A1/2); uvrstitev: SCI, Scopus, MBP; tipologijo je verificiral OSICB
 točke: 27.87, št. avtorjev: 4
- 4.** WANG, Yafeng, ČUFAR, Katarina, ECKSTEIN, Dieter, LIANG, Eryuan. Variation of maximum tree height and annual shoot growth of smith fir at various elevations in the Sygera mountains, Southeastern Tibetan plateau. *PloS one*, ISSN 1932-6203, 2012, vol. 7, no. 3, str. 1-9, e31725.
<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0031725>, doi: [10.1371/journal.pone.0031725](https://doi.org/10.1371/journal.pone.0031725). [COBISS.SI-ID [1995913](#)], [JCR, SNIP, WoS do 11. 4. 2013: št. citatov (TC): 4, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 1.00, normirano št. čistih citatov (NC): 2, Scopus do 27. 3. 2013: št. citatov (TC): 4, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 1.00, normirano št. čistih citatov (NC): 2]
 kategorija: 1A1 (Z1, A', A1/2); uvrstitev: SCI, Scopus, MBP; tipologijo je verificiral OSICB
 točke: 42.41, št. avtorjev: 4
- 5.** ČUFAR, Katarina, CHERUBINI, Martina, GRIČAR, Jožica, PRISLAN, Peter, SPINA, Stefano, ROMAGNOLI, Manuela. Xylem and phloem formation in chestnut (*Castanea sativa* Mill.) during the 2008 growing season. *Dendrochronologia*, ISSN 1125-7865, 2011, vol. 29, no. 3, str. 127-134, ilustr. <http://dx.doi.org/10.1016/j.dendro.2011.01.006>, doi: [10.1016/j.dendro.2011.01.006](https://doi.org/10.1016/j.dendro.2011.01.006).
 [COBISS.SI-ID [3117990](#)], [JCR, SNIP, WoS do 5. 11. 2013: št. citatov (TC): 6, čistih citatov (CI): 3, čistih citatov na avtorja (CIAu): 0.50, normirano št. čistih citatov (NC): 3, Scopus do 4. 12. 2013: št. citatov (TC): 7, čistih citatov (CI): 4, čistih citatov na avtorja (CIAu): 0.67, normirano št. čistih citatov (NC): 4]
 kategorija: 1A2 (Z1, A1/2); uvrstitev: SCI, Scopus, MBP; tipologijo je verificiral OSICB
 točke: 16.67, št. avtorjev: 6
- 6.** ČUFAR, Katarina, KROMER, Bernd, TOLAR, Tjaša, VELUŠČEK, Anton. Dating of 4th millennium BC pile-dwellings on Ljubljansko barje, Slovenia. *Journal of archaeological science*, ISSN 0305-4403, 2010, vol. 37, issue 8, str. 2031-2039, ilustr., doi: [doi:10.1016/j.jas.2010.03.008](https://doi.org/10.1016/j.jas.2010.03.008).
 [COBISS.SI-ID [31389741](#)], [JCR, SNIP, WoS do 3. 12. 2013: št. citatov (TC): 5, čistih citatov (CI): 2, čistih citatov na avtorja (CIAu): 0.50, normirano št. čistih citatov (NC): 8, Scopus do 1. 10. 2013: št. citatov (TC): 5, čistih citatov (CI): 3, čistih citatov na avtorja (CIAu): 0.75, normirano št. čistih citatov (NC): 13]
 kategorija: 1A1 (Z1, A", A', A1/2); uvrstitev: Scopus (d,h), SCI, SSCI, ERIHA, AHCI, MBP; tipologijo je verificiral OSICB
 točke: 32.66, št. avtorjev: 4

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Lesna biomasa kot vir dragocenih spojin
Course title:	High value added compounds from woody biomass

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	Les in biokompoziti	1,2	1,2,3,4
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	Wood and biocomposites	1,2	1,2,3,4

Vrsta predmeta / Course type teoretični predmet / theoretical course

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
10	20	10	/	5	80	5

Nosilec predmeta / Lecturer: Nosilec: Prof. dr. Primož Oven

Jeziki / Languages:	Predavanja / Lectures:	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: **Prerequisites:**

Splošni pogoji za vpis na doktorski študij

General requirements for enrolment in doctoral study.

Vsebina: _____ **Content (Syllabus outline):** _____

Potencial različnih kategoriji lesne biomase za pridobivanje proizvodov z visoko dodano vrednostjo. Globalni trendi na področju predelave ligno-celulozne biomase: pridobivanje gradnikov iz olesenele celične stene in pridobivanje naravnih produktov lesnih rastlin (ekstraktivov).
 Naravni produkti lesne biomase, sistematika in variabilnost. Posebnosti ekstrakcijskih tehnik za pridobivanje ekstraktivov iz lesne biomase. Preparativna ločba in izolacija ter kvalitativna in kvantitativna analiza spojin. Uporabni potencial lesnih ekstraktivov.
 Hierarhične zgradba lesnih vlaken. Priprava mikrofibrilirane (MFC) in nanofibrilirane celuloze ((NFC). Priprava celuloznih nanokristalov (CN). Fizikalne in kemijske lastnosti MFC, NFC in CN. Omejitve pri uporabi in modifikacija površine. Uporaba NFC in CN kot ojačitvenega materiala, kot osnove ali dodatka za filme, membrane, premaze, pene, hidrogele in aerogeje, in kot nosilcev za bioaktivne snovi iz lesne biomase. Pregled inovativne rabe lignina in hemiceluloz.

Potential of different categories of woody biomass for production of high-added value products. Global trends in the field of ligno-cellulosic biomass processing: acquisition of structural components of cell walls and natural products of wood plants (extractives).
 Natural products of woody biomass, systematics and variability. Features of extraction techniques for the production of extractive from woody biomass. Preparative separation and isolation, and qualitative and quantitative analysis of compounds. Use of extractive in different fields of applications.
 Hierarchical structure of woody fibers. Preparation of micro-fibrillated (MFC) and nano-fibrillated cellulose (NFC) cellulose. Preparation of cellulose nano-crystals (CN). Physical and chemical properties of MFC, NFC and CN. Restrictions in use and modification of cellulose surface. Application of NFC and CN as reinforcing material, as basic and additive for films, membranes, coatings, foams, hydrogels and aerogels, as well as carriers for bioactive substances from woody biomass. Overview of innovative use of lignin and hemicelluloses.

Temeljni literatura in viri / Readings:

Fengel D., Wegener G. 1989. Wood, Chemistry, Ultrastructure, Reactions. Berlin, Walter de Gruyter: 613 str.
 Hon, D.N.-S. , Shiraishi, N. 2000. Wood and cellulosic chemistry. Marcell Dekke, New York, Basel. 914.
 Rowe, J.W. Natural products of woody plants I and II. Springer Verlag. 1243 str.
 Izbrani članki v domačih in tujih specializiranih strokovnih in znanstvenih revijah.

Cilji in kompetence:

Cilji:

Pridobiti poglobljeno znanje o potencialu lesne biomase in možnostih pridobivanja produktov z visoko dodano vrednostjo. Pridobiti specializirana znanja s področja pridobivanja in uporabe ekstraktivov ter mikro- in nanofibrilirane celuloze iz lesne biomase.

Kompetence:

Doktorand je kompetenten za presojo primernosti ligno-celulozne biomase za pridobivanje produktov z visoko dodano vrednostjo. Ima ustrezne kompetence za samostojno raziskovalno delo na področju lesnih ekstraktivov in NFC.

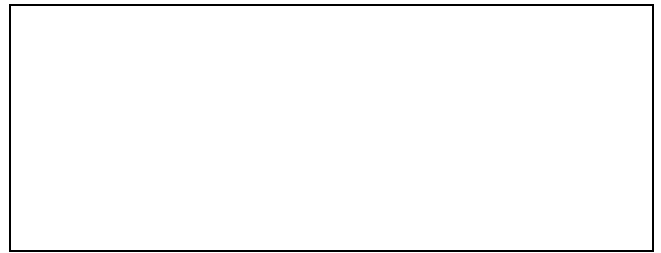
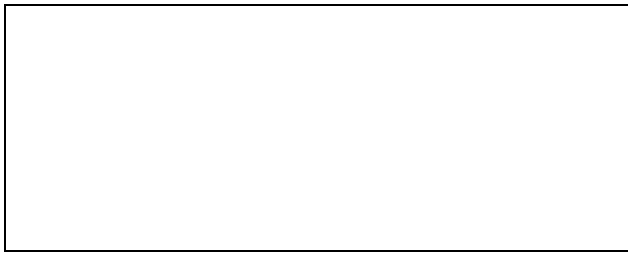
Objectives and competences:

Objectives:

To get knowledge on potential of different categories of woody biomass for production of high-added value products. To gain specialized knowledge in the field of production and use of extractives, and micro- and nano-fibrillated cellulose from woody biomass.

Competences:

Doctorand is competent for evaluation of suitability of ligno-cellulosic biomass for production of high value added products. He has competences for independent research in the field of extractives and NFC.

**Predvideni študijski rezultati:**Znanje in razumevanje:

Doktorand pozna različne kategorije lesne biomase in razume njihov potencial za pridobivanje proizvodov z visoko dodano vrednostjo. Seznanjen je s sodobnimi trendi na področju biorafinerij, s poudarkom na pridobivanju ekstraktivov in NFC. Razume ekstrakcijske tehnike in načine za izolacijo, vrednotenje in uporabo ekstraktivov. Razume pripravo MFC, NFC in CN iz lesne biomase. Seznanjen je s fizikalnimi in kemijskimi lastnostmi teh produktov. Pozna metode za modifikacijo NFC, prav tako pa možnosti njene uporabe v različnih sodobnih materialih.

Refleksija:

Doktorand je sposoben kritično ovrednotiti potencial različnih tipov lesne biomase za proizvodnjo dveh velikih skupin proizvodov, ekstraktivov in MFC ter NFC. Lahko presoja o izbiri ustreznih postopkov za pridobivanje ekstraktivov za njihovo izolacijo ter njihovo kvalitativno in kvantitativno vrednotenje. Prav tako pridobi poglobljen vpogled v produkcijo celuloznih fragmentov mikro in nanodimenzij, zelo dobro pozna njihove lastnosti ter primernost postopkov za modifikacijo teh lastnosti in možnosti za uporabo NFC in CN.

Prenosljive spretnosti:

Doktorand pridobljeno znanje uporablja pri drugih predmetih doktorskega študija. Smiselno uporablja strokovno znanstveno literaturo in druge vire v svojem raziskovalnem delu. Pridobljeno znanje dopolnjuje celosten vpogled v problematiko izkoriščanja lesne biomase.

Intended learning outcomes:Knowledge and understanding:

Doctorand understands different categories of woody biomass and understands its potential for production of high value added products. He is familiar with contemporary trends in biorefinery processing, with the accent on extractives and NFC. He understands extraction and isolation techniques as well as value and use of extractives. He understands preparation of MFC, NFC and CN from woody biomass. He knows physical and chemical features of these products. He knows methods for NFC modification and possibilities for its use in different materials.

Reflection:

Doctorand is able to critically asses potential of woody biomass for production of two groups of products, extractives and MFC and NFC. He is able to assess the suitability of appropriate procedures for production of extractives, their isolation and qualitative and quantitative evaluation. He gets deeper insight into production cellulose fragment s of micro and nano scale dimensions. He is able to reflect properties of NFC and CN and suitability for their use.

Transferrable knowledge:

Doctorand is able to use the knowledge in other courses of the study. He is able to constructively use the professional and scientific literature in his research work. Acquired knowledge fulfils integral insight into problematic of exploitation of woody biomass.

Metode poučevanja in učenja:**Learning and teaching methods:**

Predavanja (10 ur), Seminarji (20 ur), Laboratorijske vaje (10 ur), Drugo (5 ur)	Lectures (100 h) Seminar (20 h) Laboratory work (10 h) Others (5 h)
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Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Pisni izpit	70%	Oral and written exam
Seminar	30%	Seminar

Reference nosilca / izvajalcev / Lecturer's references:

REFERENCE IZVAJALCEV

Primož Oven

1. VEK, Viljem, OVEN, Primož, HUMAR, Miha. Phenolic extractives of wound-associated wood of beech and their fungicidal effect. *International biodeterioration & biodegradation*, ISSN 0964-8305. [Print ed.], 2013, vol. 77, no. 2, str. 91-97. [COBISS.SI-ID [2079369](#)], [JCR, SNIP, Scopus do 19. 12. 2013: št. citatov (TC): 3, čistih citatov (CI): 1, čistih citatov na avtorja (CIAu): 0.33, normirano št. čistih citatov (NC): 0] kategorija: 1A2 (Z1, A1/2); uvrstitev: SCI, Scopus, MBP; tipologijo je verificiral OSICB, točke: 28.88, št. avtorjev: 3
2. VEK, Viljem, OVEN, Primož, TERS, Thomas, POLJANŠEK, Ida, HINTERSTOISSER, Barbara. Extractives of mechanically wounded wood and knots in beech. *Holzforschung*, ISSN 0018-3830. Tiskana izdaja, 2013, vol. <v tisku>, no. <v tisku>, str. <v tisku>. <http://www.degruyter.com/view/j/hfsg.ahead-of-print/hf-2013-0003/hf-2013-0003.xml?format=INT>, doi: [10.1515/hf-2013-0003](https://doi.org/10.1515/hf-2013-0003). [COBISS.SI-ID [2166153](#)], [JCR, SNIP] kategorija: 1A1 (Z1, A", A', A1/2); uvrstitev: SCI, Scopus, MBP; tipologija ni verificirana točke: 27.83, št. avtorjev: 5
3. VEK, Viljem, OVEN, Primož, POLJANŠEK, Ida. Quantitative HPLC analysis of catechin in wound-associated wood and knots of beech = Kvantitativna HPLC analiza katehina u ranjenom dijelu i kvrgama bukova drva. *Drvna industrija*, ISSN 0012-6772, 2013, let. 64, št. 3, str. 231-238. [COBISS.SI-ID [2138249](#)], [JCR, SNIP, Scopus do 15. 10. 2013: št. citatov (TC): 0, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0, normirano št. čistih citatov (NC): 0] kategorija: 1A4 (Z1); uvrstitev: SCI, Scopus, MBP; tipologijo je verificiral OSICB, točke: 18.99, št. avtorjev: 3
4. VEK, Viljem, OVEN, Primož, POLJANŠEK, Ida. Content of total phenols in red heart and wound-associated wood in beech (*Fagus sylvatica* L.) = Sadržaj ukupnih fenola u crvenom srcu i ranjenom dijelu drva bukve (*Fagus sylvatica* L.). *Drvna industrija*, ISSN 0012-6772, 2013, let. 64, št. 1, str. 25-32. [COBISS.SI-ID [2091657](#)], [JCR, SNIP, Scopus do 19. 12. 2013: št. citatov (TC): 2, čistih citatov (CI): 1, čistih citatov na avtorja (CIAu): 0.33, normirano št. čistih citatov (NC): 1] kategorija: 1A4 (Z1); uvrstitev: SCI, Scopus, MBP; tipologijo je verificiral OSICB točke: 18.99, št. avtorjev: 3
5. MERELA, Maks, OVEN, Primož, SERŠA, Igor, MIKAC, Urška. A single point NMR method for an instantaneous determination of the moisture content of wood. *Holzforschung*, ISSN 0018-3830. Tiskana izdaja, 2009, vol. 63, no.3, str. 348-351. [COBISS.SI-ID [1705097](#)], [JCR, SNIP, WoS do 25. 11. 2013: št. citatov (TC): 9, čistih citatov (CI): 9, čistih citatov na

avtorja (CIAu): 2.25, normirano št. čistih citatov (NC): 13, Scopus do 12. 11. 2013: št. citatov (TC): 12, čistih citatov (CI): 12, čistih citatov na avtorja (CIAu): 3.00, normirano št. čistih citatov (NC): 18] kategorija: 1A1 (Z1, A', A1/2); uvrstitev: SCI, Scopus, MBP; tipologijo je verificiral OSICB točke: 30.13, št. avtorjev: 4

6. MERELA, Maks, PELICON, Primož, VAVPETIČ, Primož, REGVAR, Marjana, VOGEL-MIKUŠ, Katarina, SERŠA, Igor, POLIČNIK, Helena, POKORNY, Boštjan, LEVANIČ, Tom, OVEN, Primož. Application of micro-PIXE, MRI and light microscopy for research in wood science and dendroecology. V: *Proceedings of the ICNMTA2008, 11th International Conference on Nuclear Microprobe Technology and Applications, 3rd International Workshop on Proton Beam Writing, 20-25 July 2008, Debrecen, Hungary*, (Nuclear instruments & methods in physics research, ISSN 0168-583X, B, Vol. 267, Issues 12/13, 2009). Amsterdam: North-Holland, 2009, vol. 267, no. 12/13, str. 2157-2162, doi: [10.1016/j.nimb.2009.03.062](https://doi.org/10.1016/j.nimb.2009.03.062). [COBISS.SI-ID [22503463](https://www.cobiss.si/id/22503463)]

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Mikoremediacija
Course title:	Mycoremediation

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	Les in biokompoziti	1,2	1,2,3,4
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	Wood and biocomposites	1,2	1,2,3,4

Vrsta predmeta / Course type teoretični predmet / theoretical course

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
10	5	15	/	5	90	5

Nosilec predmeta / Lecturer: Nosilec: prof. dr. Franc Pohleven

Jeziki / Languages:	Predavanja / Lectures:	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

Prerequisites:

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Končan univerzitetni ali drugostopenjski bolonjski študij iz širšega področja naravoslovja, matematike in računalništva oziroma ožjega področja Vede o živi naravi (klasifikacija po Klasius-u).

Completed university studies or bologna masters in natural sciences, mathematics and computer studies or the narrower field of life sciences (Klasius classification).

Vsebina: **Content (Syllabus outline):**

Predstavljene bodo naslednje vsebine:

Glive, kot indikatorji onesnaženosti okolja. Ekologija mikoremediacije. Glivni metabolizem in potencial gliv za biorazgradnjo nevarnih odpadkov, kot so: kem. zaščiten les, pesticidi in druge toksične snovi. Pomen gliv in glivnih encimov pri ravnanju z odpadki na odlagališčih, čiščenju odpadnih industrijskih vod, kakor tudi industriji celuloze in papirja. Razbarvanje in razgradnja barvil, vključno z melaminom na predmetih kulturne dediščine z glivami. Razgradnja plastike, goriv, ostankov eksploziv in drugih sintetičnih odpadnih materialov. Pomen mikoriznih gliv za remediacijo zemljišč. Uporaba gliv za biosorpcijo in bioakumulacijo težkih kovin.

The following contents will be presented and discussed:

Fungi as environmental indicators. Ecology of mycoremediation. Fungal metabolisms and their biodegradable potential for waste impregnated wood, pesticides and others toxic chemicals. The importance of fungi and fungal enzymes in waste management on landfills, wastewaters as well as pulp and paper industry. Fungal decolourization and degradation of dyes, including melamine on cultural heritage. Decomposition of plastic, fuels, residues of explosives and other synthetic waste materials. Mycorrhizal fungi in rhizosphere remediation. Application of fungi in biosorption and bioaccumulation of heavy metals.

Temeljni literatura in viri / Readings:

Učbenik:

Singh H., 2006: MYCOREMEDIATION – Fungal Bioremediation. Wiley Interscience, John Wiley & Sons, Ltd, Hoboken, New Jersey. ISBN-13: 978-0-471-75501-2, 592 str.

Polizeli T.M. and Rai M., 2013: Fungal Enzymes, CRC Press London, New York, ISBN: 978-1-4665-9454-8, 445 str.

Pregledni in novejši znanstveni članki s področja okolja/Review and recent scientific papers on the field of environment.

Cilji in kompetence:

Študent se bo poglobil v ožjo okoljsko raziskovalno problematiko, ki jo bo lahko nadgrajeval v svoji doktorski disertaciji. Predmet ni namenjen ekstenzivni poglobitvi teoretičnega znanja, pač pa je cilj predstavitev določenih problemov in obvladovanje specifičnih metod in tehnik, ki lahko pripomorejo k rešitvi okoljskih problemom. Namenjen je tudi poznavanju pregleda predhodnih raziskav s področja bodoče doktorske disertacije študenta.

Objectives and competences:

Students will get deeper insight into environment research problems which he or she will upgrade in her/his doctoral thesis. The contents are not intended to extensively deepen the theoretical knowledge but should introduce specific problems, indicate methods and techniques with which can be addressed the environmental problems. Students should get familiar with previous research in the field of their doctoral thesis.

Predvideni študijski rezultati:**Intended learning outcomes:**

Znanje in razumevanje:
Zastavljen pristop bi se moral odraziti v pravilnem načrtovanju raziskav in poskusov, ki vodijo k potrditvi ali zavrnitvi hipotez, zastavljenih v temi doktorske disertacije.

Knowledge and understanding:
Such an approach should result in the proper planning of research experiments which can test the hypotheses raised in the doctoral thesis.

Metode poučevanja in učenja:

Neposredna predavanja nosilca, priprava in vodenje Journal clubov; priprava problemskih seminarskih nalog, diskusij in konzultacije. Pregled in poprava rešitev problemskih nalog.

Learning and teaching methods:

Frontal ex-cathedra teaching and preparation and supervision of Journal clubs; preparation of problem seminars, discussion and consultation. Assessment and correction of problem tasks.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
- Predstavitev problemske seminarske naloge	50	- Presentation of problem solution,
- sodelovanje na journal club-ih.	50	- participation at journal clubs and/or seminars.

Reference nosilca / izvajalcev / Lecturer's references:

1. ULČNIK, Ajda, KRALJ CIGIĆ, Irena, POHLEVEN, Franc. Degradation of lindane and endosulfan by fungi, fungal and bacterial laccases. *World journal of microbiology & biotechnology*, ISSN 0959-3993, 2013, vol. 29, no. 12, str. 2239-2247. [COBISS.SI-ID [2159753](#)]
2. ULČNIK, Ajda, KRALJ CIGIĆ, Irena, ZUPANČIČ-KRALJ, Lucija, TAVZES, Črtomir, POHLEVEN, Franc. Bioremediation of lindane by wood-decaying fungi = Biorazgradnja lindana pomoću gljiva uzročnika truljenja drva. *Drvna industrija*, ISSN 0012-6772, 2012, vol. 63, no. 4, str. 271-276. [COBISS.SI-ID [2080137](#)]
3. TAVZES, Črtomir, PALČIČ, Jernej, FACKLER, Karin, POHLEVEN, Franc, KOESTLER, Robert John. Biomimetic system for removal of fungal melanin staining on paper. *International biodeterioration & biodegradation*, ISSN 0964-8305. [Print ed.], 2012, vol. 84, str. 307-313, doi: [10.1016/j.ibiod.2012.07.022](https://doi.org/10.1016/j.ibiod.2012.07.022). [COBISS.SI-ID [512788267](#)]
4. ULČNIK, Ajda, KRALJ CIGIĆ, Irena, ZUPANČIČ-KRALJ, Lucija, TAVZES, Črtomir, POHLEVEN, Franc. Razgradnja endosulfana z glivama Hypoxylon fragiforme in Gloeophyllum trabeum = Degradation of endosulfan with Hypoxylon fragiforme and Gloeophyllum trabeum. *Les*, ISSN 0024-1067, 2011, let. 63, št. 5, str. 227-231. [COBISS.SI-ID [1930633](#)]
5. ULČNIK, Ajda, ZUPANČIČ-KRALJ, Lucija, TAVZES, Črtomir, POHLEVEN, Franc. Mikoremediacija lindana v tekočih kulturah gliv Pleurotus ostreatus in Hypoxylon fragiforme = Mycoremediation of lindane in liquid cultures of Pleurotus ostreatus and Hypoxylon fragiforme. *Les*, ISSN 0024-1067, 2010, let. 62, št. 5, str. 216-221. [COBISS.SI-ID

[1810057](#)]

6. ULČNIK, Ajda, VAUKNER, Maja, TAVZES, Črtomir, POHLEVEN, Franc. Glivne lakaze : encimi neverjetnih sposobnosti = Fungal laccases : enzymes of incredible abilities. *Les*, ISSN 0024-1067, 2011, let. 63, št. 3, str. 49-54. [COBISS.SI-ID [1891209](#)]

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet: Razvoj in LCA analiza novega izdelka v lesni industriji
Course title: Development and LCA analysis of new product in wood industry

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	Les in biokompoziti	1,2	1,2,3,4
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	Wood and biocomposites	1,2	1,2,3,4

Vrsta predmeta / Course type

teoretični predmet / theoretical course

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
10	35	/	/	/	80 ur	5

Nosilec predmeta / Lecturer:

Nosilec: prof. dr. Leon Oblak

Jeziki / Languages:

Predavanja / Lectures: slovenski / angleški
Slovene / English
Vaje / Tutorial: slovenski / angleški
Slovene / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**Prerequisites:**

Splošni pogoji za vpis na doktorski študij.

General requirements for enrolment in doctoral study.

Vsebina:**Content (Syllabus outline):**

- Pojem in pomen novih izdelkov
- Proces razvoja novih izdelkov (iskanje, zbiranje in ocenjevanje idej, poslovno-tržna analiza, tehnološko-proizvodno, oblikovno in tržno razvijanje novega izdelka, tržno testiranje novega izdelka)
- Življenjski cikli izdelkov in strategije
- LCA analiza novega izdelka
- Standardi, metodologija, certificiranje na področju okoljskih vplivov za etično in socialno odgovorno snovanje in načrtovanje strateških možnosti
- Shema za okoljsko označevanje ogljičnega odtisa izdelkov (koncept od zibelke do zibelke)
- Določanje scenarijev ob končni življenjski dobi izdelkov
- 3R trajnostno načrtovanje: Reduce, Reuse, Recycle.
- Primeri dobrih praks za ogljično učinkovito leseno gradnjo

- The concept and importance of new products
- The process of new product development (exploration, collection and evaluation of ideas, business and market analysis, technology manufacturing, design and marketing of new product development, market testing of a new product)
- The life cycles of products and strategy
- LCA analysis of a new product
- Standards, methodologies and certifications in the field of environmental impacts assessment and their use for ethical and socially responsible design, planning and evaluation of strategic development opportunities of organizations
- Scheme for eco-labeling carbon footprint of products (the concept of cradle to cradle)
- Lifecycle scenario design for product end-of-life strategy
 - Sustainable Planning 3Rs: Reduce, Reuse, Recycle.
 - Good practices for carbon-efficient wood construction

Temeljni literatura in viri / Readings:

Oblak, L. 2013. Trženje lesnih izdelkov in storitev. Biotehniška fakulteta, Oddelek za lesarstvo, Ljubljana, 175 str.

Kotler, P. 1996. Marketing management. Slovenska knjiga, Ljubljana, 832 str.

Muthu, S. S. 2014. Assessment of Carbon Footprint in Different Industrial Sectors, Volume 1; Springer, 292 str.

Kitek Kuzman, M., Kutnar, A. 2014. Contemporary Slovenian Timber Architecture for Sustainability, Springer, Zurich, 170 str. ISBN 978-3-319-03634-2
(http://www.springer.com/energy/energy+efficiency/book/978-3-319-03634-2?fb_action_ids=10151782916531909&fb_action_types=og.likes&fb_source=aggregation&fb_aggregation_id=288381481237582)

PAS 2050. 2011. Specification for the assessment of the life cycle greenhouse gas emissions of goods and services. BSI, UK.

Ecimovic, T. et al. 2007. The sustainable (development) future of mankind. Korte: Medosi, Slovenia. ISBN 978-961-91826-2-8.

Cilji in kompetence:

Cilji:
Cilj predmeta je, da študent osvoji temeljna praktična znanja o razvoju in LCA analizi novega izdelka ter da spozna načine, metode in modele, ki lahko tržno naravnemu podjetju omogočijo, da izpolni pričakovanja porabnikov boljše od konkurentov.

Objectives and competences:

Objectives:
The aim of the course is that the student acquires a basic practical knowledge on the development and LCA analysis of a new product and to learn the techniques, methods and models that can the market-oriented company allow to meet the expectations of

Kompetence:
 Študent je usposobljen za spremljanje dogajanj v konkurenčnem okolju podjetja, povezanih z razvojem novega izdelka in za hitro reagiranje ob spremembah. Obvlada razvoj in LCA analizo novega izdelka.

consumers better than competitors.
Competences:
 The student is trained to follow developments in the competitive environment, companies associated with new product development and for rapid reaction to the change. Mastered the development and LCA analysis of a new product.

Predvideni študijski rezultati:

Znanje in razumevanje:
 Študent razvije sposobnosti in veščine za sprejemanje samostojnih strokovnih odločitev, povezanih z razvojem in LCA analizo novega izdelka. Pozna načine in pristope k pridobivanju podatkov in informacij, ki so za to potrebne.

Intended learning outcomes:

Knowledge and understanding:
 Students develop the ability and skills to adopt independent professional decisions related to the development and LCA analysis of a new product. He knows the methods and approaches to obtaining data and information that are needed for this purpose.

Metode poučevanja in učenja:

- Predavanja
- Seminar

Learning and teaching methods:

- Lectures
- Seminar

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Pisni/ustni izpit	50 %	Written/oral exam
Seminar	50 %	Seminar

Reference nosilca / izvajalcev / Lecturer's references:

Prof. dr. Leon Oblak

1. LIPUŠČEK, Igor, BOHANEK, Marko, OBLAK, Leon, ZADNIK STIRN, Lidija. A multi-criteria decision-making model for classifying wood products with respect to their impact on environment. Int. j. life cycle assess., 2010, vol. 15, no. 4, str. 359-367.
2. OBLAK, Leon, JOŠT, Matej. Methodology for studying the ecological quality of furniture. Drv. ind., 2011, vol. 62, no. 3, str. 171-176.
3. BERGINC, Jordan, HROVATIN, Jasna, FELTRIN, Matjaž, MAECHTIG, Saša J., ZUPANČIČ, Anton, OBLAK, Leon. Analysis of cooperation between furniture industry and designers in product development process = Analiza suradnje proizvođača namjestaja i dizajnera u procesu razvoja proizvoda. Drv. ind., 2011, vol. 62, no. 2, str. 129-136.
4. HROVATIN, Jasna, PREKRAT, Silvana, BERGINC, Jordan, ŠERNEK, Milan, ZUPANČIČ,

Anton, OBLAK, Leon, MEDVED, Sergej. Strength comparison of joints at window frames. *Drewno - Wood*, vol. 56, no. 189, str. 128-135.

5. OBLAK, Leon, ZADNIK STIRN, Lidija, MORO, Maja, HROVATIN, Jasna, MOLE, Samo, KITEK KUZMAN, Manja. Choice of quantitative method for forecasting of parquet sales = Izbor kvantitativne metode za predviđanje prodaje parketa. *Drv. ind.*, 2012, vol. 63, no. 4, str. 249-254.
6. GLAVONJIĆ, Branko, OBLAK, Leon. Consumption of woody biomass in industry, commercial and public facilities in Serbia : present state and possible contribution to the share of renewable sources in final energy consumption. *Therm. sci.*, 2012, vol. 16, no. 1, str. 7-19.

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Reologija in kinetika utrjevanja lepil za les
Course title:	Rheology and curing kinetics of wood adhesives

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni doktorski študijski program BIOZNANOSTI 3. stopnja	Les in biokompoziti	1,2	1,2,3,4
Interdisciplinary Doctoral Study Programme in BIOSCIENCES 3rd cycle	Wood and biocomposites	1,2	1,2,3,4

Vrsta predmeta / Course type teoretični predmet / theoretical course

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
10	30	/	/	/	85	5

Nosilec predmeta / Lecturer: Nosilec: prof. dr. Milan Šernek

Jeziki / Languages:	Predavanja / Lectures:	slovenski / angleški Slovene / English
	Vaje / Tutorial:	slovenski / angleški Slovene / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: **Prerequisites:**

Splošni pogoji za vpis na doktorski študij	General conditions for enrollment in doctoral study
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Vsebina: **Content (Syllabus outline):**

- Reologija polimerov in lepil za lepljenje lesa
- Viskoelastične lastnosti lepil
- Lezenje in relaksacija v lepilnih spojih
- Elastični in viskozni strižni modul
- Temperatura steklastega prehoda
- Spremembe stanja med utrjevanjem duromernih lepil
- Reologija talilnih lepil
- Analiza utrjevanja lepil
- Vpliv časa in temperature na utrjevanje lepil
- Kinetika utrjevanja urea-formaldehidnih, melamin-formaldehidnih in fenol-formaldehidnih lepil z DSC
- Dielektrična analiza lepil
- Dinamična mehanska analiza lepil
- Avtomatsko ovrednotenje trdnosti lepilnega spoja
- Modeliranje procesa utrjevanja lepil pri vročem stiskanju, MFK in AMFK

- Rheology of polymers and adhesives for wood bonding
- Viscoelastic properties of adhesives
- Creep and relaxation in adhesive bonds
- Elastic and viscous shear modulus
- Glass transition temperature
- Transitions during of curing of thermosetting adhesives.
- Rheology of hot-melt adhesives
- Analysis of adhesive cure
- Influence of time and temperature on adhesive cure
- Curing kinetics of urea-formaldehyde, melamine-formaldehyde in phenol-formaldehyde adhesive with DSC
- Dielectric analysis of adhesives
- Dynamical mechanical analysis of adhesives
- Automated bonding evaluation system
- Modelling of curing process of adhesives at hot-pressing, MFK in AMFK

Temeljni literatura in viri / Readings:

1. Menard, P.K. 1999. Dynamic mechanical analysis. CRC Press, Boca Raton, 208 str. (izbrana poglavja)
2. Mulligan, D. 2003. Cure monitoring for composites and adhesives. Rapra Technology, Shawbury, 112 str. (izbrana poglavja)
3. Runt, P.J., Fitzgerald, J.J. 1997. Dielectric Spectroscopy of Polymeric Materials: Fundamentals and Applications, ACS, Washington, 461 str. (izbrana poglavja)
4. Whorlow, R.W. 1992. Rheological techniques. Ellis Horwood, New York, 460 str. (izbrana poglavja)
5. Revijalni članki s področja, tekoča periodika, druga učna gradiva...«

Cilji in kompetence:

Cilj predmeta je poglobljeno spoznati in razumeti reološke lastnosti lepil za les in poznati mehanizme adhezije pri lepljenju lesa in/ali drugih materialov. Poznati analitske metode za proučevanje utrjevanja lepil in se usposobiti za znanstveno raziskovalno delo na področju lepljenja. Znati analizirati in modelirati proces utrjevanja lepila s sodobnimi računalniškimi orodji.

Objectives and competences:

The objective of the course is to get deep and detailed knowledge about rheological properties of wood adhesives and to understand mechanisms of adhesion when bonding of wood and/or other materials. Get familiar with analytical methods for studying the curing of adhesives and to become qualified for scientific research in the field of bonding. Get knowledge for analysis and modelling of the curing process of adhesives with the software.

Predvideni študijski rezultati:

Intended learning outcomes:

Znanje in razumevanje:

Študent razume pomen reoloških lastnosti lepil za doseganje zadostne adhezije pri lepljenju lesa in drugih materialov. Razume vpliv parametrov lepljenja na kinetiko utrjevanja lepil. Pozna metode za proučevanje in analizo procesa utrjevanja lepila ter trdnostne lastnosti lepilnih spojev.

Uporaba:

Znanje uporabi za razumevanje tehnologije lepljenja lesa in lepljenje drugih materialov. Znanje uporabi pri razvoju novih lepil in postopkov lepljenja. Izvaja lahko zahtevne preskuse in raziskave z laboratorijskimi instrumenti in opremo.

Refleksije:

Poznavanje lepil za les in druge materiale, obvladovanje tehnologije lepljenja lesa in drugih materialov, izvajanje zahtevnih raziskovalnih metod na področju reologije lepil in lepljenja.

Prenosljive spretnosti:

Študent pridobi spretnosti uporabe znanstvene literature in priprave znanstvenega članka. Znanje študent uporablja in nadgrajuje pri vseh tehnoloških predmetih.

Knowledge and understanding:

The student understands the meaning of rheological properties of adhesives for achievement of sufficient adhesion at bonding of wood and other materials. He/she understands the effect of bonding parameters on the curing kinetics of adhesives. He/she knows methods for monitoring and analysing the process of curing of adhesives and strength properties of adhesive bonds.

Use:

Knowledge allows student to understand the technology of wood bonding and bonding of other materials. Knowledge can be used in development of new adhesive and bonding processes. Student is capable of conducting the comprehensive tests and studies with laboratory instruments and equipment.

Reflection:

Knowledge about wood adhesives, technology of bonding of wood and other materials, and complex methods for research in the field of rheology of adhesives and bonding.

Transferable skill:

Student gets skills how to use scientific literature and prepare a scientific paper. Upgrade and transfer of gained knowledge at all technology related courses.

Metode poučevanja in učenja:

Predavanja (10 ur) in seminar (30 ur) v multimedijskih predavalnicah.

Learning and teaching methods:

Lectures (10 hours) and seminar (30 hours) in multimedia equipped lecture rooms.

Načini ocenjevanja:

Delež (v %) /

Weight (in %)

Assessment:

- Pisni izpit - Seminar	75 % 25 %	- Written exam - Seminar
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Reference nosilca – izvajalca / Lecturer's references:

1. ŠERNEK, Milan, KAMKE, Frederick A. Application of dielectric analysis for monitoring the cure process of phenol formaldehyde adhesive. International journal of adhesion and adhesives, ISSN 0143-7496. [Print ed.], 2007, vol. 27, str. 562-567. [COBISS.SI-ID 1463945]
2. ŠERNEK, Milan, BOONSTRA, Michiel, PIZZI, Antonio, DESPRES, Aurelien, GÉRARDIN, Philippe. Bonding performance of heat treated wood with structural adhesives. Holz als Roh- und Werkstoff, ISSN 0018-3768. [Print ed.], 2008, vol. 66, no. 3, str. 173-180. [COBISS.SI-ID 1628041]
3. JOŠT, Matej, ŠERNEK, Milan. Shear strength development of the phenol-formaldehyde adhesive bond during cure. Wood Science and Technology, ISSN 0043-7719, 2009, vol. 43, no. 1/2, str. 153-166. [COBISS.SI-ID 1662089]
4. MRAVLJAK, Maksimilijan, ŠERNEK, Milan. The influence of curing temperature on the rheological properties of epoxy adhesives = Utjecaj temperature otvrdnjavanja na reološka svojstva epoksidnih ljepila. Drvna industrija, ISSN 0012-6772, 2011, vol. 62, br. 1, str. 19-25. [COBISS.SI-ID 1896585]
5. UGOVŠEK, Aleš, ŠERNEK, Milan. Characterisation of the curing of liquefied wood by rheometry, DEA and DSC. Wood Science and Technology, ISSN 0043-7719, 2013, vol. 47, no. <v tisku>, str. 1-15. <http://link.springer.com/article/10.1007/s00226-013-0565-4>, doi: 10.1007/s00226-013-0565-4. [COBISS.SI-ID 2112905]
6. KARIŽ, Mirko, KITEK KUZMAN, Manja, ŠERNEK, Milan. The effect of the heat treatment of spruce wood on the curing of melamine-urea-formaldehyde and polyurethane adhesives. Journal of adhesion science and technology, ISSN 0169-4243, 2013, vol. 27, no. <v tisku>, str. 1-11. <http://dx.doi.org/10.1080/01694243.2013.764809>, doi: 10.1080/01694243.2013.764809. [COBISS.SI-ID 2090633]