SVEUČILIŠTE U ZAGREBU, FAKULTET ŠUMARSTVA I DRVNE TEHNOLOGIJE
UNIVERSITY OF ZAGREB, FACULTY OF FORESTRY AND WOOD TECHNOLOGY

## Graduate Study Wood Technology Processes

# Syllabus
## from Acad. Year 2022/23

# LIST OF COMPULSORY AND ELECTIVE COURSES WITH CLASS HOURS AND ECTS CREDITS

| Year of study: I | | | | | | | |
|---|---|---|---|---|---|---|---|
| Semester: Winter | | | | | | | |
| COURSE | COURSE TEACHER | L | E | F | e-learning | ECTS | Compulsory / elective |
| Thermohydromechanical processing of wood | Prof. Stjepan Pervan, PhD<br>Assist. Prof. Miljenko Klarić, PhD. | 30 | 30 | 8 | 2. | 6 | Compulsory |
| Sawmilling techniques | Assoc. Prof. Josip Ištvanić, PhD | 30 | 30 | 0 | 2. | 6 | Compulsory |
| Quantitative Methods for Operations Research | Assist. Prof. Azra Tafro, PhD | 30 | 15 | 0 | 1. | 5 | Compulsory |
| Production Management | Assist. Prof. Ivana Perić, PhD | 30 | 15 | 8 | 2. | 5 | Compulsory |
| CNC Techniques in Woodworking | Assoc. Prof. Goran Mihulja, PhD. | 30 | 15 | 16 | 2. | 4 | Compulsory |
| Wood modifications | Prof. Hrvoje Turkulin, PhD<br>Prof. Vlatka Jirouš Rajković, PhD<br>Assoc. Prof. Vjekoslav Živković, PhD<br>Assoc. Prof. Marin Hasan, PhD<br>Assoc. Prof. Bogoslav Šefc, PhD | 30 | 15 | 0 | - | 4 | Elective |
| Operation Management | Assist. Prof. Ivana Perić, PhD | 30 | 15 | 8 | 2. | 4 | Elective |
| **In total** | | 180 | 120 | 40 | | 30 | |

| Year of study: I | | | | | | | |
|---|---|---|---|---|---|---|---|
| Semester: Summer | | | | | | | |
| COURSE | COURSE TEACHER | L | E | F | e-learning | ECTS | Compulsory / elective |
| Veneer and plywood technology | Prof. Mladen Brezović, PhD | 30 | 30 | 0 | 2. | 5 | Compulsory |
| Technology of panels made from fragmented wood | Prof. Vladimir Jambreković, PhD<br>Assist. Prof. Nikola Španić, PhD | 30 | 30 | 8 | 2. | 5 | Compulsory |
| Automation and measurement in woodworking industry | Assoc. Prof. Igor Đukić, PhD | 30 | 15 | 0 | 2. | 4 | Compulsory |
| Material handling | Prof. Ružica Beljo Lučić, PhD | 30 | 15 | 16 | 2. | 4 | Compulsory |
| Professional practice | Prof. Anka Ozana Čavlović, PhD | | | 160 | 2. | 4 | Compulsory |
| Wood Fibers and Paper Technology | Prof. Vladimir Jambreković, PhD<br>Assist. Prof. Nikola Španić, PhD | 30 | 15 | 8 | 2. | 4 | Elective |
| Special Technology of Wood Drying | Prof. Stjepan Pervan, PhD | 30 | 15 | 8 | 2. | 4 | Elective |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Multi-axial Woodworking | Assoc. Prof. Goran Mihulja, PhD. | 30 | 15 | 8 | 2. | 4 | Elective |
| Wood industry power supply | Assist. Prof. Branimir Šafran, PhD<br>Assist. Prof. Kristijan Radmanović, PhD | 30 | 15 | 0 | 2. | 4 | Elective |
| **In total** | | 180 | 120 | 256 | | 30 | |

| Year of study: II | | | | | | | |
|---|---|---|---|---|---|---|---|
| Semester: Winter | | | | | | | |
| COURSE | COURSE TEACHER | L | E | F | e-learning | ECTS | Compulsory / elective |
| Technology of wood building components | Prof. Hrvoje Turkulin, PhD<br>Assoc. Prof. Vjekoslav Živković, PhD | 30 | 30 | 24 | 2. | 6 | Compulsory |
| Processes of wood finishing | Prof. Vlatka Jirouš Rajković, PhD | 30 | 30 | 16 | 2. | 6 | Compulsory |
| Technology of wood protection | Assoc. Prof. Marin Hasan, PhD | 30 | 15 | 8 | 2. | 5 | Compulsory |
| Applied Statistics | Prof. Anamarija Jazbec, PhD | 30 | 15 | 0 | 3. | 5 | Compulsory |
| Timber harvesting | Prof. Tomislav Poršinsky, PhD<br>Assist. Prof. Andreja Đuka, PhD | 30 | 15 | 8 | 2. | | Elective |
| Quality management and assurance | Assist. Prof. Kristina Klarić, PhD<br>Assoc. Prof. Krešimir Greger, PhD | 30 | 15 | 8 | 2. | 4 | Elective |
| Designing wood industry plants | Assoc. Prof. Ivica Župčić, PhD | 30 | 15 | 8 | 2. | 4 | Elective |
| Protection of industrial environment | Prof. Anka Ozana Čavlović, PhD<br>Prof. Ružica Beljo Lučić, PhD | 30 | 15 | 8 | 2. | 4 | Elective |
| **In total** | | 180 | 120 | 80 | | 30 | |

| Year of study: II | | | | | | | |
|---|---|---|---|---|---|---|---|
| Semester: Summer | | | | | | | |
| COURSE | COURSE TEACHER | L | E | F | e-learning | ECTS | Compulsory / elective |
| Professional project | | | | 120 | | 4 | Compulsory |
| Diploma work | | | | | 2. | 14 | Compulsory |
| | Assoc. Prof. Alan Antonović, PhD | 30 | 15 | 0 | 2. | 4 | Elective |
| Design of wood materials production process | Assist. Prof. Miljenko Klarić, PhD.<br>Prof. Mladen Brezović, PhD<br>Assist. Prof. Nikola Španić, PhD | 30 | 15 | 0 | 2. | 4 | Elective |
| Biomass and solid wood biofuels production | Assist. Prof. Branimir Šafran PhD | 30 | 15 | 0 | 2. | 4 | Elective |
| Wood machining optimization | Prof. Ružica Beljo Lučić, PhD<br>Assoc. Prof. Igor Đukić, PhD | 30 | 15 | 0 | 2. | 4 | Elective |

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|---|---|---|---|---|---|---|---|
| Quality of wood building products | Assoc. Prof. Vjekoslav Živković, PhD | 30 | 15 | 0 | 2. | 4 | Elective |
| **In total** | | 90 | 45 | 120 | | 30 | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Stjepan Pervan, PhD<br>Assist. Prof. Miljenko Klarić, PhD. | 1.7. Number of ECTS credits | 6 |
| 1.2. Course title | Thermohydromechanical processing of wood | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+30+8 |
| 1.3. Course code | 235703 | 1.9. Expected enrolment in the course | 25 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |

| 2. COURSE DESCRIPTION | |
|---|---|
| 2.1. Course objectives | The aim of the course is to train experts - specialists for independent: comprehensive work, planning, development, monitoring, control, analysis and modification of all thermohydromechanical processes of logs, sawn timber, veneer and wood particles. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C2- Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing, |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Knowledge of the thermohydromechanical wood processes.<br>2. Conduct optimal procedures of thermohydromechanical wood processing.<br>3. Optimize the procedures of thermohydromechanical wood processing.<br>4. Know, evaluate and select the optimal technology of thermhydromechanical wood processing, in accordance with the requirements of production. |
| 2.5. Course content (syllabus) | Physical, anatomical and chemical scientific basics of thermohydromechanical processing of wood and wood materials, hygroscopicity, anisotropy of shrinkage and swelling, elasto-plastic properties of wood under different conditions, measurement of water content in wood by destructive and non-destructive methods, determination of macro and microclimatic conditions of raw and dried material storage, classic kiln dryier with and without air exchange - details of performance, wood drying schedules - analysis and modification, types of control and regulation systems - parameter control, computer control of wood drying process in situ and remotely, non-standard drying methods, implementation of drying quality standards, steaming of solid wood, steaming and boling of veneer logs, thermohydromechanical bending processes of solid wood, technical drying of wood particles, technical drying of veneer, energy of hydrothermal processes, wood defects in thermohydromechanical wood processing and prevention of their occurrence, technology selection and cost calculations of thermohydromechanical processes. Implementation of research and preparation of reports on the analysis of the process of thermohydromechanical wood processing. |

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|---|---|---|---|---|---|---|---|---|---|
| 2.6. Format of instruction | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☒ field work | | | ☒ independent assignments<br>☒ multimedia and the internet<br>☒ laboratory<br>☒ work with mentor<br>☐ (other) | | | 2.7. Comments: | | |
| 2.8. Monitoring student work | Class attendance | YES | | Research | YES | | Oral exam | YES | |
| | Experimental work | YES | | Report | | | (other) | | |
| | Essay | | | Seminar paper | YES | | (other) | | |
| | Preliminary exam | YES | | Practical work | | | (other) | | |
| | Project | | | Written exam | YES | | ECTS credits (total) | 6 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | | | | | | | | | |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | Pervan, S.(2019): Handbook for technical drying of wood. University handbook. Faculty of Forestry Zagreb University. | YES | NO |
| | Simpson W.T. (1991): Dry kilns operator manual. 274 str. USDA, Madison, Wisconsin | NO | Inernet |
| | Trübswetter, T. (2009): HolztrocknungVerfahren zur Trocknung von Schnittholz - Planung von Trocknungsanlagen. Hanser Fachbuch, 204 str. | NO | Possible to buy online |
| | Pervan, S. (2009): Techology of wood processing by steam. University book. Faculty of Forestry Zagreb University. 166 p. | YES | |
| 2.12. Optional literature | 1. Ross, R. J. (2010): Wood handbook-Wood as an engineering material. USDA, FPL, Madison, Wisconsin, 508 p.<br>2. Perre, P., Keey, R.B. (2014): Handbook of industrial drying: Drying of Wood: Principles and Practices. Taylor and Francis, str. 822-872.<br>Possible to download from internet | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assoc. Prof. Josip Ištvanić, PhD | 1.7. Number of ECTS credits | 6 |
| 1.2. Course title | Sawmilling techniques | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+30+0 |

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|---|---|---|---|
| 1.3. Course code | 235705 | 1.9. Expected enrolment in the course | 25 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |

## 2. COURSE DESCRIPTION

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|---|---|
| 2.1. Course objectives | Develop the basic knowledge necessary to know the method of assembling a sawblade arrangement. To get acquainted with the techniques, methods and success of sawmill processing of significant wood species and to acquire practical skills in their application. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C2 - Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing,<br>C3 - Design technologies for primary and final wood treatment, develop, improve and optimize production, and apply knowledge from the field of technique and management in the wood industry,<br>C4 - Measure and evaluate quality parameters of wooden products (for building purposes) and interpret their size and meaning,<br>C6 - Enhance existing technologies as well as implement new technologies in the wood industry, |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1.Suggest optimum saw blades arrangement for round wood sawing of our most important wood species.<br>2.Suggest optimum saw blades arrangement for possible further sawn wood processing.<br>3.Suggest a plan for sawing for individual wood species.<br>4.Evaluate and compare the success of sawing according to the criteria of round and sawn wood quantitative yield<br>5.Evaluate and compare the success of sawing according to the criteria of round and sawn wood value yield<br>6.Design and suggest possible technological improvements in some obscure sawmill production.<br>7.Active participation in designing new sawmill plants.<br>8.Plan, organize and manage production in the sawmill at the operational and strategic level.<br>9.Adjust the capacities of machines in sawmill<br>10.Review and evaluate the current technological state of production in sawmill. |
| 2.5. Course content (syllabus) | Saw blade arrangement. Methods of creating the saw blade arrangement. Conversion of fir and spruce logs. Conversion of beech logs. Conversion of oak logs. Conversion of the other wood species. Approach to sawmill plant. design. Live sawing of fir and spruce logs. Cant sawing of fir and spruce logs. Production of squares, small squares and laths. Live sawing of beech logs. Cant sawing of beech logs. Live sawing of oak logs. Sawing of railway sleepers. |

| 2.6. Format of instruction | | | 2.7. Comments: |
|---|---|---|---|
| | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☐ field work | ☒ independent assignments<br>☒ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other) | Instructions, task examples, links and other materials are available on the Merlin e-learning system. |

| 2.8. Monitoring student work | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Class attendance | YES | | Research | YES | | Oral exam | YES | |

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|---|---|---|---|---|---|---|---|---|---|
| | Experimental work | | | Report | | | (other) | | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | | | Practical work | | | (other) | | |
| | Project | | | Written exam | YES | | ECTS credits (total) | 6 | |

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|---|---|---|---|
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | |
| 2.10. Student responsibilities | Regular attendance and active participation in lectures and exercises, making exercises and conducting exams. | | |
| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
| | Brežnjak, M. 1997: Pilanska tehnologija drva, I dio, Udžbenik, Sveučilište u Zagrebu, Šumarski fakultet (odabrana poglavlja). | NO | Merlin e-learning system |
| | Brežnjak, M. 2000: Pilanska tehnologija drva, II dio, Udžbenik, Sveučilište u Zagrebu, Šumarski fakultet (odabrana poglavlja). | YES | Merlin e-learning system |
| | Dević, I.; Ištvanić, J., 2003: Alati i strojevi u obradbi drva 1, Element, Zagreb. (odabrana poglavlja) | YES | |
| | Goglia, V. 1994: Strojevi i alati za obradu drva I dio, Sveučilište u Zagrebu, Šumarski fakultet. (odabrana poglavlja) | NO | |
| 2.12. Optional literature | 1.Merzelj, F. 1996: Žagarstvo: Udžbenik, Kmečki glas, Ljubljana.<br>2.Gornik Bučar, D.; Merzelj, F. 1998: Žagarski praktikum, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za lesarstvo.<br>3.Nikolić, M. 2004: Prerada drveta na pilanama, udžbenik, Univerzitet u Beogradu, Šumarski fakultet, Beograd | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assist. Prof. Azra Tafro, PhD | 1.7. Number of ECTS credits | 5 |
| 1.2. Course title | Quantitative Methods for Operations Research | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+0 |
| 1.3. Course code | 235706 | 1.9. Expected enrolment in the course | 25 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Students are introduced to basic concepts in linear algebra and discrete mathematics, with an overview of selected methods in operations research. The objective of the course is to demonstrate the application of mathematical objects to objects in the real world, and to | | |

<table>
<tr><td></td><td colspan="9">describe their interactions through mathematical operations, using examples from forestry. Choice of topics in the course is variable and subject to students' interests.</td></tr>
<tr><td>2.2. Enrolment requirements and/or entry competences required for the course</td><td colspan="9">-</td></tr>
<tr><td>2.3. Learning outcomes at the level of the programme to which the course contributes</td><td colspan="9">A3: Apply simpler methods of operation research<br>B4: Plan and analyse material handling, solve problems of transport, storage and selection of transport technique, analyse factors influencing the efficiency and expenses of wood and wooden, materials transport and storage.<br>C3: Design technologies for primary and final wood treatment, develop, improve and optimize production, and apply knowledge from the field of technique and management in the wood industry<br>D1: Recommend resource usage through the management of a process which consists of planning, organizing, directing and controlling,<br>D2: Perform tasks in the field of industrial management in wood refinement and furniture manufacturing, micro planning, assignment distribution, optimization of manufacturing decisions, production management and work control</td></tr>
<tr><td>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td colspan="9">1. Analyzing and solving mathematical problems based on learned mathematical concepts and modeling situations outside a mathematical context.<br>2. Connecting quantitative methods with engineering practice.<br>3. Solving a constrained maximization or minimization problem.<br>4. Using the graphical method to solve a standard minimization problem.<br>5. Organizing optimal production using linear programming..<br>6. Solving the transport problem..<br>7. Distinguishing multiple-criteria methods: multiple goal methods and optimal choice methods.<br>8. Constructing a decision tree for a given problem.<br>9. Recognizing situation types when making decisions.<br>10. Comparing criteria importance in multiple-criteria decision-making.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td colspan="9">Introduction to operations research. Definition Development. Application of operations research. Examples from the wood industry. Mathematical modeling. Basic linear algebra.Systems of linear equations. Matrix inverse.<br>Linear programming. LP model graphical method in linear programming. Simplex method. Duality.<br>Sensitivity analysis. Transportation methods. Practical examples.Integer programming. Graph theory. Shortest path problem. Decision tree. CPM and PERT methods. Queuing theory. Application to the production process.Decision theory. Game theory. Multiple-criteria programming. Goal programming. Modern methods of multiple-criteria programming. Econometrics.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☐ partial e-learning<br>☐ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td rowspan="4">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td></td><td>Report</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td>YES</td><td></td><td>Practical work</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Project | | | Written exam | YES | | ECTS credits (total) | 5 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | | | | | | | | | |
| 2.11. Required literature (available in the library and/or via other media) | Title | | | | Availability in the library | | Availability via other media | | |
| | Kalpić, D., Mornar, V.: Operacijska istraživanja, DRIP, Zagreb, 1996. | | | | YES | | | | |
| 2.12. Optional literature | 1. Elezović, N.: Linearna algebra, Element, Zagreb, 2003.<br>2. Bronson, R.,Govindasami N.:. Schaum's Outline of Theory and Problems of Operations Research. New York: McGraw-Hill, 1997.<br>3. Slack N.: Operations Management, Prentice Hall, 2001. | | | | | | | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assist. Prof. Ivana Perić, PhD<br>Karla Kremenjaš, mag.ing.techn.lign. | 1.7. Number of ECTS credits | 5 |
| 1.2. Course title | Production Management | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |
| 1.3. Course code | 235707 | 1.9. Expected enrolment in the course | 25 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Students gain general and specific knowledge from the area of production management, adjusted to specific issues of the production of wood processing companies. Particular attention is given to the knowledge in the field of micro planning, job distribution, optimisation of production decisions, production management and work control. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A1 - Explain the position and trends of the wood industry in the country and worldwide.<br>A2 - Independently gather data, statistically process, present and analyses gathered data, discuss and make conclusions based on analysed data and distinguish the possibilities of different, interpretation of the same problem analysed in different ways.<br>D1 - Recommend resource usage through the management of a process which consists of planning, organizing, directing and controlling.<br>D2 - Perform tasks in the field of industrial management in wood refinement and furniture manufacturing, micro planning, assignment distribution, optimization of manufacturing decisions, production management and work control.<br>D3 - Organize and manage tasks of wood materials trade and transfer. | | |

<table>
<tr><td></td><td colspan="9">D4 - Manage and perform tasks in wood industry entrepreneurship.<br>D5 - Perform the most complex tasks in all types of companies dealing with processing, refinement and wood trade, as well as in consultancy and engineering companies.<br>E5 - Perform activities and tasks in publicist writing and the media related to the wood profession.</td></tr>
<tr><td>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td colspan="9">1. Explain the underlying economic concepts, and the concepts and functions of management.<br>2. Apply managerial skills.<br>3. Define production strategies, production strategy model, types of production strategies and production goals.<br>4. Gain basic knowledge and concepts of production planning and management.<br>5. Identify and apply microeconomic and macroeconomic models.<br>6. Prepare project documentation and technical reports applying modern technologies.<br>7. Identify, formulate and solve engineering problems by using familiar methods and procedures</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td colspan="9">Introduction and basic concepts. Fundamentals of management theory. Functions and tasks of management. Introduction to production management. Process and operation planning. Planning methods. Supply and demand planning. Strategic planning: nature and purpose of planning; vision, mission, and goals; strategies, policies and assumptions of planning in wood technology processes. Business system competitiveness. Organizing: the nature of organizing and entrepreneurship; organizational structure; organizational structure design; organizational functioning; effective organization and organizational culture. Human resource management: human resource management; evaluating career outcomes and strategies; staffing worldwide; salaries and the method of calculating salaries. Leadership: human factors and motivation; leadership; committees and group decision-making; communication. Controlling - controlling: controlling - system and procedure; control techniques and information technology; management of production functions; overall control. Preparation of technology-oriented investment project.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="4">☒ lectures<br>☒ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☒ (exercises in computer practicum)</td><td colspan="2">2.7. Comments:<br>NOTE<br>2.9. Preliminary exame: 2 exams</td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td></td><td>Report</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td>YES</td><td></td><td>Practical work</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>5</td><td></td></tr>
<tr><td></td><td colspan="9"></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9"></td></tr>
<tr><td>2.11. Required literature (available in the library and/or via other media)</td><td colspan="4">Title</td><td colspan="2">Availability in the library</td><td colspan="3">Availability via other media</td></tr>
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|---|---|---|---|
| | 1.Sikavica, P., Bahtijarević-Šiver, F., Pološki Vokić, N.: Temelji menadžmenta, Školska knjiga, Zagreb, 2008. | NO | YES, Merlin e-learning system |
| | Jacobs, R. F., Chase, R. B.: Upravljanje operacijama i lancem opskrbe, XIII izdanje, MATE, Zagreb, 2017. | NO | YES, Merlin e-learning system |
| 2.12. Optional literature | Shroeder, R.G.: Upravljanje proizvodnjom, IV izdanje, MATE, Zagreb, 1999 | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assoc. Prof. Goran Mihulja, PhD. | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | CNC Techniques in Woodworking | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+16 |
| 1.3. Course code | 235708 | 1.9. Expected enrolment in the course | 25 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | The student is familiarize with the possible applications of the CNC technique in final wood processing.<br>Students will acquire knowledge in programming NU machines, their application and execution. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C2: Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing,<br>C5: Choose and apply the CNC technique in final wood treatment. | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Explain the possibilities of application of NC and CNC machines in the final wood processing<br>2. Distinguish and categorize the basic types of NC and CNC machines based on their capabilities (saws, planers, milling machines, machining centers,…)<br>3. Propose the application of different CNC machines for the production of final products based on the production program<br>4. Plan the optimal way of using the CNC machining center for the production of final products using: "macros", components, block commands, different processing planes, workpiece fastening systems and tools<br>5. Design the sequences and parameters of the processing of the final product elements at the CNC machining center<br>6. Organize the machining center tool database and tool changers<br>7. Prepare machining with a CNC machine using different methods of creating programs and processing subroutines (graphic programming, CAD, CAD / CAM software, ...).<br>8. Conduct the process of preparing CAM software based on the capabilities of the machining center or production system | | |

<table>
<tr><td>2.5. Course content (syllabus)</td><td colspan="9">Application of CNC technique final wood processing. Possibilities and limitations of CNC machines and machining center production.<br>Types, construction forms and divisions of CNC machines. Elements of safety for work with CNC machines.<br>Methods of production preparation (programming) on CNC machines: on-machine programming, programming with NC software package, graphic programming, programming with CAD system, with digitization, "Teach in" programming.<br>Machining center tool database, tool changers, tool setting and adjustments.<br>Selection of operations and execution plan for machining with CNC machines based on key issues of advanced wood processing (cutting, surface assessment, dynamic behaviour of tools and machines, vibration problems, material response and sawdust extraction).<br>Positioning and fixing of workpieces. Creating templates for workpiece positioning. Possibilities of setting tool paths and regulating machining parameters.<br>Advanced processing using "macros", components and block commands. Processing on arbitrary planes. Setting up processing by CAD. Pockets and engraving.<br>Multi-element production systems "nesting", CAD/CAM systems in production.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ independent assignments<br>☒ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td></td><td>Report</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td>YES</td><td></td><td>Practical work</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td>YES</td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>4</td><td></td></tr>
<tr><td colspan="9"></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9"></td></tr>
<tr><td rowspan="4">2.11. Required literature (available in the library and/or via other media)</td><td colspan="5">Title</td><td colspan="2">Availability in the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td colspan="5">Alain Albert: Understanding CNC Routers, FPInovations - Forintek Division, 2010, str.10-100.</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">Irons, I.: Learn CNC Secrets; Quickly Learn the Basic Concepts of CNC, FistFire Publishing Hobart, WA FistFire LLC, 2007, str.1-142.</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">Mihulja, G.: Računalom podržana proizvodnja drvom i drvnim materijalima I, Interni studenski priručnik.</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>2.12. Optional literature</td><td colspan="9">1. Madison, J.: CNC MACHINING HANDBOOK, Ind. press INC. 1996.<br>2. Laika, A.: Programmieren von CNC Holzearbeitungmaschinen, Rosenheim, 1991.<br>3. Csanady, E., Magoss, E.: Mechanics of Wood Machining, Springer, Berlin, 2013.<br>4. Ljuljka, B.: Tehnologija proizvodnje namještaja, Zagreb, 1980, str. 1-257.<br>5. Tkalec, S., Prekrat, S.: Konstrukcije proizvoda od drva – osnove drvnih konstrukcija, Sveučilišni udžbenik Šumarski fakultet i Znanje, Zagreb, 2000.</td></tr>
</table>

| | |
|---|---|
| | 6. Goglia, V.: Strojevi i alati za obradu drva I dio, Sveučilište u Zagrebu, Šumarski fakultet, 1994.<br>7. Franjo Nađ dipl.ing.: Priručnik za programiranje, upotrebu i održavanje obradnog centra TECH 80, str.1-25. |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Hrvoje Turkulin, PhD<br>Prof. Vlatka Jirouš Rajković, PhD<br>Assoc. Prof. Vjekoslav Živković, PhD<br>Assoc. Prof. Marin Hasan, PhD<br>Assoc. Prof. Bogoslav Šefc, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Wood modifications | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+0 |
| 1.3. Course code | 33666 | 1.9. Expected enrolment in the course | 25 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Information about the potential for hindering of natural shortcommings or for improvement of wood technical properties by chemical, physical and enzymatic modifications. Learning about the basic principles of wood modifications and the processes. Practical performance of laboratory methods of physical and chemical modifications, measurement of improvement in relevant wood properties. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | B3 - Manage procedures and processes of improving natural wood disadvantages using chemical, physical and enzymatic modifications,<br>C6 - Enhance existing technologies as well as implement new technologies in the wood industry. | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1.Differentiate unmodified wood from modified as well as modified from chemically protected and explain their advantages and disadvantages.<br>2. Differentiate the different types of wood modification (thermal, chemical, ...) and the essential parameters of the modification regime.<br>3. Select those properties of modified wood that are important for a particular product (eg, durability in external floors, dimensional stability in flooring in the interior).<br>4. Recommend the type of wood and type of modification for a given product according to the hazard classes (HRN EN).<br>5. Recommend the tests and independently test the selected properties of modified wood (test for loss of mass modification, examine biological resistance, hygroscopic properties, | | |

<table>
<tr><td></td><td colspan="9">...), interpret the obtained results and determine the durability class according to HRN EN norms.<br>6. Compare the examined properties of modified wood and select the optimum for the desired product (eg loss of mass, dimensional stability, hardness, bending strength or tension, modulus of elasticity, loss of mass due to the action of fungi).<br>7. Review the most important parameters and compare the effect of some modification parameters to suggest correction of modification regime to achieve the required properties (eg, correction of the temperature or treatment time required to achieve a certain degree of durability or color change level in thermal modification in the water vapor).<br>8. Individually or in a team, make a durability insurance project for a new product from modified wood in terms of its use, to recommend the optimum modification procedure while respecting the ecological principles (eg, application of additional chemicals) and economic requirements (eg energy needs) and present it to a group of people.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td colspan="9">Analysis of the grounds for wood modification (natural shortcommings-hygroscopicity, liability to weathering and biological deterioration), and improvement of tehcnical properties – mechanical, thermal, acoustic properties, adhesion and permeability. Review of the modification technologies: surface modifications (physical – roughness and plasma treatments, application of chemical treatments, irradiations, finishing). Bulk wood modifications (heat treatments, acetylation, densification, infiltration, cell wall modifications, enzymatic modifications). Theoretical and practical aspects of wood modification by laboratory heat treatment, acetylation, surface treatments (NaOH, cytric acid, DMDHEU, HALS and UV primers), by impregnation (oil and PEG): measurements of the changes in dimensional stability, hygrophobicity (contact angle), colour fastness, surface integrity, strength changes, biological resistance. Review of the potential commercial applications of modified wood.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☒ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☐ partial e-learning<br>☐ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td rowspan="5">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td>YES</td><td></td><td>Report</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td></td><td></td><td>Practical work</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>4</td><td></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9"></td></tr>
<tr><td rowspan="3">2.11. Required literature (available in the library and/or via other media)</td><td colspan="5">Title</td><td colspan="2">Availability in the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td colspan="5">Zbirka članaka o modifikacijama drva (European conference on wood modification 2014., 2015., 2017., 2018.)</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">Živković, V. i dr.<br>Influence of natural surface ageing on bonding quality of thermally modified oak</td><td colspan="2"></td><td colspan="2"></td></tr>
</table>

| | | | |
|---|---|---|---|
| | and beech wood // Drvna industrija, 70 (2019), 3; 273-278 | | |
| | Živković, V. i dr. Surface properties of thermally modified wood floorings // Proceedings of the Eighth European Conference on Wood Modification / Helsinki: Aalto University, 2015. str. 115-118 | | |
| 2.12. Optional literature | | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assist. Prof. Ivana Perić, PhD<br>Karla Kremenjaš, mag.ing.techn.lign. | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Operation Management | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |
| 1.3. Course code | 235717 | 1.9. Expected enrolment in the course | 20 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Acquisition of specific knowledge and skills in operational methods of production process management in wood processing companies. Introduction to the basics of information systems, their design, structure, development and implementation and evaluation. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A1 - Explain the position and trends of the wood industry in the country and worldwide.<br>A2 - Independently gather data, statistically process, present and analyses gathered data, discuss and make conclusions based on analysed data and distinguish the possibilities of different, interpretation of the same problem analysed in different ways.<br>D1 - Recommend resource usage through the management of a process which consists of planning, organizing, directing and controlling.<br>D2 - Perform tasks in the field of industrial management in wood refinement and furniture manufacturing, micro planning, assignment distribution, optimization of manufacturing decisions, production management and work control.<br>D3 - Organize and manage tasks of wood materials trade and transfer.<br>D4 - Manage and perform tasks in wood industry entrepreneurship.<br>D5 - Perform the most complex tasks in all types of companies dealing with processing, refinement and wood trade, as well as in consultancy and engineering companies.<br>E5 - Perform activities and tasks in publicist writing and the media related to the wood profession. | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning | 1. Identify the places and roles of the production process within the company.<br>2. Apply operational methods and techniques in planning and monitoring production and business processes and explain the basic performance indicators of the production process. | | |

<table>
<tr><td>outcomes)</td><td colspan="9">3. Propose a software solution for integrated planning and production management (teamwork with project developer)<br>4. Plan business and production database models (warehouses, raw materials, basic assets, merchandise, etc.).<br>5. Relate the business and production functions within the company with hardware and software solutions<br>6. Apply the acquired knowledge and skills to solve a specific taks in the real sector</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td colspan="9">Introduction. Production processes in the wood industry. Production planning. Optimization methods and techniques as a support to modeling of process management in wood processing and furniture production. The concept of modern production in wood processing and furniture production. Introduction to computer integrated manufacturing. Systems in the company: production, business and information. Development of information systems. The concept of the development of computer support for production preparation. Characteristics of information systems for managing production processes and resources: MRP (Material Requirement Planning), MRP II (Material Resource Planning) and ERP (Enterprises Resource Planning). Structure of information systems in manufacturing companies. Information systems subsystems. Principles of information system design. The process of obtaining information. Technological database. Building a database of production resources. Integration of business and production activities in the company with the support of information systems. Implementation of information systems. Evaluation of information solutions</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☒ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☒ work with mentor<br>☐ exercises in computer practicum</td><td colspan="3">2.7. Comments:<br>NOTE<br>2.9. Preliminary exame: 2 exams</td></tr>
<tr><td rowspan="5">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td></td><td>Report</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td>YES</td><td></td><td>Practical work</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>4</td><td></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9"></td></tr>
<tr><td rowspan="3">2.11. Required literature (available in the library and/or via other media)</td><td colspan="5">Title</td><td colspan="2">Availability in the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td colspan="5">Grladinović T.: Upravljanje proizvodnim sustavima u preradi drva i proizvodnji namještaja, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 1999., str. 1-298.</td><td colspan="2">NO</td><td colspan="2">YES, Merlin e-learning system</td></tr>
<tr><td colspan="5">Majdandžić, N.; Lujić, R.; Matičević, G.; Šimunović, G.; Majdandžić, I.: Upravljanje proizvodnjom, Sveučilište u Osijeku, Strojarski fakultet, Slavonski Brod, 2001.</td><td colspan="2">NO</td><td colspan="2">YES, Merlin e-learning system</td></tr>
<tr><td>2.12. Optional literature</td><td colspan="9">Schroeder, R.: Upravljanje proizvodnjom - Odlučivanje u funkciji proizvodnje, MATE, 1999.</td></tr>
</table>

# COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Mladen Brezović, PhD | 1.7. Number of ECTS credits | 5 |
| 1.2. Course title | Veneer and plywood technology | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+30+0 |
| 1.3. Course code | 33671 | 1.9. Expected enrolment in the course | 15 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |

| 2. COURSE DESCRIPTION | |
|---|---|
| 2.1. Course objectives | Acquired knowledge enables students to lead and manage technology of veneer and plywood production, and to plan a technological process. Also, it enables students to incorporate new scientific facts in standard technology or introduce new technologies in the veneer and plywood industry. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C2 - Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing,<br>C6 - Enhance existing technologies as well as implement new technologies in the wood industry. |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Analyze and organize the technological systems for the production of veneer and plywoods.<br>2. Analyze the selection criteria for technological solutions in veneer and plywood production and propose the most optimal solution.<br>3. Calculate and analyze the existing ones and design optimum technological parameters for veneer and plywood production.<br>4. Calculate the production line capacity for veneer production and suggest improvements.<br>5. Design the technological phases of production and determine the optimum parameters for veneer and plywood production.<br>6. Plan and organize veneer production processes with high degree of automation.<br>7. Analyze the interaction of the constructional elements of the plywood and design the optimum construction of the ply wood according to the requirements.<br>8. Determine and calculate material properties of plywood materials and propose procedures for optimizing these properties.<br>9. Apply numerical methods in the analysis of plywood properties (basics) and propose methods of production and methods of testing properties of optimized plywood. |
| 2.5. Course content (syllabus) | Veneers. Technological systems for manufacturing of slicing veneer. Technological systems for manufacturing of peeling veneer. Criteria for selection of mechanical process depending on raw materials. Technological parameters of veneer slicing. Capacity of a veneer slicing machine. Technological parameters for veneer peeling. Capacity of a veneer peeling machine. Planning of a system of veneer manipulation. Veneer drying. Processing of veneer by a clipper. Planning of veneer storage. Planning of technological process for manufacture of slicing and peeling veneers. Continuous production processes for slicing and rotary cut |

<table>
<tr><td></td><td colspan="9">veneer, with a high level of automatisation. Continuous semiautomatic systems for a slicing veneer production. Veneer jointing. Planning of a veneer-jointing line. Veneer plywood. Planning of a technological process for a veneer plywood manufacture. Designing of a veneer plywood property using different construction solutions. Polar diagram. Coefficient of quality. Adhesives for a veneer plywood production. Selection of adhesive and adhesive mixture. Laminated veneer lumber (LVL). Structural LVL. Technological processes of PSL production.<br>Long grained plywood. Moulded plywood. HF Presses. Composite plywood. Reinforced plywood. Synthetic materials for manufacturing reinforced and, composite plywood. Adhesives for manufacturing reinforced and, composite plywood. Core plywood. Analysis of a plywood structural elements interaction. Methods of estimation and determination plywood properties. Non-destructive methods for analysing of plywood properties. Numerical methods for analysing of plywood properties.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☒ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☐ field work</td><td colspan="3">☐ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td>YES</td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td></td><td>Report</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td></td><td></td><td>Practical work</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>5</td><td></td></tr>
<tr><td></td><td colspan="9"></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9">Regular attendance and active participation in lectures and exercises, write and present seminar, passing on partial exams and final exams.</td></tr>
<tr><td rowspan="3">2.11. Required literature (available in the library and/or via other media)</td><td colspan="4">Title</td><td colspan="3">Availability in the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td colspan="4">Veneer and plywood technology. https://moodle.srce.hr/2020-2021/course/view.php?id=76115</td><td colspan="3">NO</td><td colspan="2">YES Online (Merlin)</td></tr>
<tr><td colspan="4">Mešić, N.,1998.: Furniri, furnirske i stolarske ploče. Grafika Šaran, Sarajevo</td><td colspan="3">NO</td><td colspan="2"></td></tr>
<tr><td>2.12. Optional literature</td><td colspan="9">1. Kljak, J., Grubišić, I., Brezović, M., Trajković, J.: Brodograđevna furnirska ploča. Brodogradnja, 50(2002)2, 213-218.<br>2. Brezović, M., Jambreković, V., Kljak, J.: Utjecaj karbonskih vlakana na neka relevantna svojstva furnirskih ploča. Drvna industrija, 53(2002)1, 23-31.<br>3. Brezović, M., Jambreković, V., Pervan, S.: Bending properties of carbon fiber reinforced plywood. Wood research, 48(2003)4, 13-24.<br>4. Kljak, J., Brezović, M., Jambreković, V.: Plywood stress optimisation using the finite element method. Wood Research, 51(2006.)1, 1-10.<br>5. Brezović, M.; Kljak, J.; Pervan, S.; Antonović, A. (2010): Utjecaj kuta orijentacije sintetičkih vlakana na savojna svojstva kompozitne furnirske ploče. Drvna industrija, 61 (2010) 4, 239-243.<br>6. Brezović, M., Pervan, S., Petrak, J., Prekrat, S.: Metoda procjene svojstava uslojenog drva. Drvna industrija, 69 (2018) 1, 49-54.</td></tr>
</table>

# COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Vladimir Jambreković, PhD<br>Assist. Prof. Nikola Španić, PhD | 1.7. Number of ECTS credits | 5 |
| 1.2. Course title | Technology of panels made from fragmented wood | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+30+8 |
| 1.3. Course code | 235709 | 1.9. Expected enrolment in the course | 20 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |

| 2. COURSE DESCRIPTION | |
|---|---|
| 2.1. Course objectives | Gaining of knowledge about technical regulations, planing and production management, and particleboard and fibreboard quality assurance for panels produced with or without adhesives, in dry or wet processes, by cold pressing or in hot presses and moulds. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C2 - Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. to identify and evaluate production technologies and process equipment for the production of panels from fragmented and defibrated wood<br>2. to design the characteristics of basic and auxiliary raw materials depending of the production process and the type of product made from fragmented and/or defibrated wood<br>3. to manage the technological processes in the production of boards and shaped products (moldings) made from fragmented and defibrated wood<br>4. to optimize the panel properties by correcting the technological parameters<br>5. to recommend the methods and technical conditions for the panel overlaying<br>6. apply the technical regulations for wooden panels<br>7. to design and implement new technologies in the production of boards and shaped products from fragmented and defibrated wood |
| 2.5. Course content (syllabus) | Development stages in technolgy of panels from fragmented wood. Production technologies. Management of technological processes. Definition of properties of panels made from fragmented wood. Panel characteristics planning. Raw material preparation. Particles and fibres characteristics planning. Factors affecting the characteristics of bonding materials and chemical additives. Planning of characteristics of chemical components. The raw material characteristics influence on panel properties. Specifics of recycled wood composites technology. The elaboration of technological parameters in production processes. The significance of size separation and particles dosage. Specifics of dosage of fibres and chemical components. Structure and quality of „mats“ from fragmented wood. Technological processes at hot and cold pressing. Factors influencing on pressing and quality of panels. Specifics of continuous pressing processes. Technological processes in the |

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|---|---|
| | production of wood-plastic composites (WPC). Influence of chemical additives on WPC properties. Technology of wood cellulose based biocomposite and nanocomposite materials. Final processing of composite materials. Conditioning and moisture content equalisation. Panel classification.<br>Technological conditions of panel overlaying with veneers and synthetic materials. Technologcal conditions of overlaying panels edges. Stability of panels overlaid with synthetic materials. The influential factors of overlaying quality. The influence of overlaying materials on panels properties. Monitoring , analysis and presentation of technological parameters. Control and management of technological phases of panel production. Optimisation of panel properties with correction of technological parameters. Quality assurance. The development of new technologies in production of panels from fragmented wood. |

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|---|---|---|---|---|---|---|---|---|---|
| 2.6. Format of instruction | ☒ lectures<br>☒ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☒ field work | | | ☐ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other) | | | 2.7. Comments: | | |
| 2.8. Monitoring student work | Class attendance | YES | | Research | | | Oral exam | YES | |
| | Experimental work | | | Report | | | (other) | | |
| | Essay | | | Seminar paper | YES | | (other) | | |
| | Preliminary exam | | | Practical work | | | (other) | | |
| | Project | | | Written exam | YES | | ECTS credits (total) | 5 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | Regular attendance and active participation in lectures and exercises, write and present seminar, passing on partial exams and final exams | | | | | | | | |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | Španić, N., Jambreković, V.: Particleboard and Fiberboard Production Technology, (Internal script), Faculty of Forestry, Zagreb, 2021. (in writing) | NO | YES |
| | Thoemen, H., Irle, M., Šernek, M. (eds.): Wood-Based Panels: An Introduction for Specialists. Brunel University Press, 2010. | NO | YES |
| 2.12. Optional literature | Moslemi, A. A. Particleboards - Volume 2: Technology. Southern Illinois University Press, 1974. | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assoc. Prof. Igor Đukić, PhD | 1.7. Number of ECTS credits | 4 |

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|---|---|---|---|
| 1.2. Course title | Automation and measurement in woodworking industry | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+0 |
| 1.3. Course code | 33673 | 1.9. Expected enrolment in the course | 20 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Acquiring the knowledge for the selection, optimal usage and maintenance machinery for wood processing. Acquiring the basics which are required for assigning project tasks to the manufacturers of special equipment for wood processing. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C2 - Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing. | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Calculate the marginal error of analog and digital instrument.<br>2. Distinguish measurement errors by origin.<br>3. Determine the components of the measurement uncertainty and calculate the measurement uncertainty of the directly measured quantity for simpler cases and express the measurement result.<br>4. Opisati ulogu osnovnih dijelova regulacijskog i mjernog lanca.<br>5. Distinguish the basic transfer characteristics of measurement transducers and analyze them on the example of frequently used transducers in the wood industry.<br>6. Calculate the static characteristic and static sensitivity of the mixed-connected units in the control circuit.<br>7. Analyze the main parameters of the first and second order systems. | | |
| 2.5. Course content (syllabus) | Basics of metrology. Units of measurement of the SI system and basic units outside the SI system. Basic equation of metrology. Numerical and dimensional equations..<br>Measurement errors by origin. Measuring accuracy, repeatability, reproducibility and precision.<br>Basics of statistical processing of measurement results. Regression analysis.<br>Limit error of analog and digital instruments and elements of control systems.<br>Expression of measurement result. Measurable insecurity. Type A uncertainty component and type B uncertainty component. Standard uncertainty of directly measured quantity.<br>Basic characteristics of elements of measuring systems and automation systems. Classification of waveforms. Basic processing of dynamic signals.<br>Characteristics of zero order systems - static characteristics. Static sensitivity.<br>Linearization of a nonlinear static characteristic in the vicinity of a working point, by the tangent approximation procedure, and by the Taylor series approximation.<br>Analysis of the first order system.<br>Second order system analysis.<br>Measurement transducers of non-electrical to electrical quantities. General features. Displacement, speed and acceleration transducers.<br>Deformation, force and torque measuring transducers.<br>Temperature, pressure and relative humidity transducers.<br>Application of "ON-OFF" control in automatic control.<br>Application and characteristics of P, I, D controllers in automatic control circuits. | | |

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|---|---|---|---|---|---|---|---|---|---|
| 2.6. Format of instruction | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☐ field work | | | ☐ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other) | | | 2.7. Comments: | | |
| 2.8. Monitoring student work | Class attendance | YES | | Research | | | Oral exam | YES | |
| | Experimental work | YES | | Report | | | (other) | | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | YES | | Practical work | | | (other) | | |
| | Project | | | Written exam | YES | | ECTS credits (total) | 4 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | Regular attendance and active participation in lectures and exercises. Passing on partial exams and final exams. | | | | | | | | |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | Božičević, J. 2008: Temelji automatike, 1. knjiga – Sustavno gledište i automatika, automatsko reguliranje. Školska knjiga, Zagreb | YES | |
| | Božičević, J. 2008: Temelji automatike, 2. knjiga – Mjerni pretvornici i mjerenje. Školska knjiga, Zagreb | YES | |
| 2.12. Optional literature | 1. Stadler, W. 1995: Analytical Robotics and mechatronics. McGraww-Hill.<br>2. Šurina, T. 1987: Automatska regulacija. Školska knjiga, Zagreb.<br>3. Rajić, F. 1980: Osnove automatike I dio – Mjerenje neelektričnih veličina, Zagreb.<br>4. Rajić, F. 1980: Osnove automatike II dio – Automatsko reguliranje procesa, Zagreb. | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Ružica Beljo Lučić, PhD<br>Assist. Prof. Matija Jug, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Material handling | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+16 |
| 1.3. Course code | 33674 | 1.9. Expected enrolment in the course | 20 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |

| 2. COURSE DESCRIPTION | |
|---|---|
| 2.1. Course objectives | Course objective is a development of technical and technological knowledge of material handling design in wood industry, material handling analysis, solving of issues associated with transport and storage, as well as the choice of transport equipment. Within the framework of the course, students are to acquire knowledge of factors having an impact upon efficiency and costs of transport and storage of wood and wooden materials. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A2 - Independently gather data, statistically process, present and analyses gathered data, discuss and make conclusions based on analysed data and distinguish the possibilities of different, interpretation of the same problem analysed in different ways.<br>B4 - Plan and analyse material handling, solve problems of transport, storage and selection of transport technique, analyse factors influencing the efficiency and expenses of wood and wooden, materials transport and storage.<br>C3 - Design technologies for primary and final wood treatment, develop, improve and optimize production, and apply knowledge from the field of technique and management in the wood industry.<br>E3 - Gather, process and interpret reference sources and prepare simpler professional or scientific papers. |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Collect and analyse relevant information and research results on the subject related to material handling in wood processing and furniture production.<br>2. Present in a clear and concise way professional information related to handling materials in wood processing and furniture production.<br>3. Investigate, measure or calculate the properties of bulk wood materials and analyze the influencing factors on properties of materials important for their transport, storage and packaging (bulk density, bulk angle, granulation).<br>4. Plan and conduct research related to material handling (transport, storage, packaging) by surveying participants in wood processing industry and furniture production<br>5. Self-study the task of material handling and suggest technical and organizational solutions in certain time and financial conditions.<br>6. Calculate the required size of the storage facilities depending on the type, quantity, layout of the material, used transport equipment etc.<br>7. Create and use simple Excel tables to keep track of the stock of material in the storage facilities.<br>8. Produce self-conceptual design of dust and chips extraction and transportation system using the data of manufacturers of pipes, fans, electric motors and wood particle separators. |
| 2.5. Course content (syllabus) | General theory of handling material. Basic principles of material handling. Methodological basics of analysis and solving material flows. Transport systems in automated production. Automated transportation in the storage facilities. Automated transport equipment and transport routes. Solving transport problems in the wood industry. Transport cost analysis. Minimize transport costs. Transport systems in the wood industry. Transport and storage of logs and sawn timber. Organization of log yards with regard to the used transport equipment. Choice of transport equipment. Transport and storage of semi-finished and finished products. Storage facilities of final products. Storage equipment. Storage conditions. Designing a storage facilities. Storage facilities transport equipment. Determining the size of the storage space. Usability of storage facilities space. Transport and storage of bulk wood material. Defining the properties of the material. Types and properties of particles of bulk wood material. Types of transport and transport equipment. Types of storage facilities and silo. Calculate the required silo capacity. Design of air conveyor systems. Energy analysis of transport systems. Efficiency of transport systems. Heat balance of plants with air conveyor. Comparison of air and mechanical conveyors from the energy aspect. Options for reduction of energy consumption of air conveyors. Packaging. Packaging material. Internal protection. Packaging for wood products. Basic types of transport packaging in the wood industry. Machines and tools for packaging wood products. Wooden packaging. Production and testing of wooden packaging. |

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|---|---|---|---|---|---|---|---|---|---|
| 2.6. Format of instruction | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☒ field work | | | ☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☒ work with mentor<br>☐ (other) | | | 2.7. Comments: | | |
| 2.8. Monitoring student work | Class attendance | YES | | Research | YES | | Oral exam | YES | |
| | Experimental work | | | Report | | | (other) | | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | | | Practical work | YES | | (other) | | |
| | Project | YES | | Written exam | YES | | ECTS credits (total) | 4 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | | | | | | | | | |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | Sever, S. 1988: Transport u drvnoj industriji, autorizirani rukopis, Zagreb. | NO | |
| | Oluić, Č. 1991: Transport u industriji, Rukovanje materijalom I. dio. Sveučilišna naklada, Zagreb, 1 – 278. | YES | |
| | Rukovanje materijalom, Power Point prezentacije, 2020. | NO | |
| 2.12. Optional literature | | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Anka Ozana Čavlović, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Professional practice | 1.8. Number of hours in semester (L+E+F+e-learning) | 0+0+160 |
| 1.3. Course code | 235710 | 1.9. Expected enrolment in the course | 20 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |

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|---|---|
| 2.1. Course objectives | The aim of the professional practice is to gain experience and insight into the wood technology activity and to connect the acquired theoretical knowledge with examples from practice. During the stay in a specific work situation, the student has the opportunity to understand and realize the importance of developing business responsibility, communication skills and teamwork. Based on recording and observing the features of the wood technology process and business, the student proposes and elaborates their improvements. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A2: Independently gather data, statistically process, present and analyse gathered data, discuss and make conclusions based on analysed data and distinguish the possibilities of different, interpretation of the same problem analysed in different ways,<br>A3: Apply simpler methods of operation research.<br>B1: Apply current technical regulations in planning and managing systems, managing production and managing and assuring quality of wood, wooden materials and final products<br>B2: Apply scientific insights on wood as a renewable material and optimise wood usage through the application of techniques and technologies for reuse of wood excess<br>B3: Manage procedures and processes of improving natural wood disadvantages using chemical, physical and enzymatic modifications,<br>B4: Plan and analyse material handling, solve problems of transport, storage and selection of transport technique, analyse factors influencing the efficiency and expenses of wood and wooden, materials transport and storage.<br>C1: Apply technological processes of mechanical and thermo-chemical wood refinement in the manufacturing of wood fibres and paper,<br>C2: Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing,<br>C3: Design technologies for primary and final wood treatment, develop, improve and optimise production, and apply knowledge from the field of technique and management in the wood industry,<br>C4: Measure and evaluate quality parameters of wooden products (for building purposes) and interpret their size and meaning<br>C5 :Choose and apply the CNC technique in final wood treatment,<br>C6: Enhance existing technologies as well as implement new technologies in the wood industry,<br>C7: Manage the industrial environment of wood processing and the wooden, chemically protected wood waste and excess.<br>D1: Recommend resource usage through the management of a process which consists of planning, organising, directing and controlling,<br>D2: Perform tasks in the field of industrial management in wood refinement and furniture manufacturing, micro planning, assignment distribution, optimisation of manufacturing decisions, production management and work control,<br>D3: Organise and manage tasks of wood materials trade and transfer,<br>D4: Manage and perform tasks in wood industry entrepreneurship,<br>E3: Gather, process and interpret reference sources and prepare simpler professional or scientific papers,<br>E4: Conduct courses in vocational secondary school and other similar schools,<br>E5: Perform activities and tasks in publicist writing and the media related to the wood profession. |
| 2.4. Expected learning | 1. Apply the acquired knowledge and skills acquired during the study in specific situations |

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|---|---|
| outcomes at the level of the course (3 to 10 learning outcomes) | 2. Apply communication skills in new work environments<br>3. Record and comment on the features of the wood technology process and business and propose optimization and rationalization in accordance with applicable standards and regulations<br>4. Design and propose possible improvements in the existing wood production and business<br>5. Solve technical problems independently or as a team<br>6. Form a sense of responsibility and motivation to perform assigned tasks<br>7. Prepare a written report on professional practice |
| 2.5. Course content (syllabus) | According to the contract between the Faculty and the wood processing employer, the student attends a professional practice for 20 working days under the guidance of two mentors, a teacher and an practice employee. According to the company's activities, the student is given a task in accordance with the learning outcomes from professional practice. During the practice, the student keeps a diary or report on professional practice. |

| 2.6. Format of instruction | | | 2.7. Comments: |
|---|---|---|---|
| | ☐ lectures<br>☐ seminars and workshops<br>☐ exercises<br>☐ *online in entirety*<br>☐ partial e-learning<br>☐ field work | ☒ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☒ work with mentor<br>☐ (other) | |

| 2.8. Monitoring student work | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Class attendance | | | Research | | | Oral exam | | |
| | Experimental work | | | Report | YES | | work with mentor | YES | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | | | Practical work | | | (other) | | |
| | Project | | | Written exam | | | ECTS credits (total) | 4 | |

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|---|---|---|---|
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | |
| 2.10. Student responsibilities | | | |
| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
| | | | |
| | | | |
| 2.12. Optional literature | | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Vladimir Jambreković, PhD<br>Assist. Prof. Nikola Španić, PhD | 1.7. Number of ECTS credits | 4 |

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|---|---|---|---|
| | Assoc. Prof. Alan Antonović, PhD | | |
| 1.2. Course title | Wood Fibers and Paper Technology | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |
| 1.3. Course code | 235719 | 1.9. Expected enrolment in the course | 10 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Gaining of knowledge about macro, micro and nano structure of wood fibers, processes of obtaining certain types of wood fibers, regeneration and of products of cellulose and fibers regeneration, and application of acquired knowledge in order to independently monitor and control the mechanical pulp, semi-cellulose, cellulose and nanocellulose production.<br>Gaining of knowledge about the specifics of production and subsequent processing of paper in order to independently manage technological processes of paper production from wood and substitute lignocellulosic raw materials. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C1 - Apply technological processes of mechanical and thermo-chemical wood refinement in the manufacturing of wood fibers and paper | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. to analyse and evaluate the processes of mechanical defibration of wood, and of producing semi- cellulose and technical cellulose<br>2. to recommend appropriate methods and to manage technological processes of wood delignification and regeneration of chemicals<br>3. to identify and recommend the methods, and to manage and evaluate processes of subsequent chemical treatment of produced wood fibres and regenerated cellulose<br>4. to identify and evaluate the procedures of nano cellulose production<br>5. to evaluate, recommend and manage technological processes of producing paper, cardboard and corrugated cardboard<br>6. to improve the properties of paper and of wood fibres and nano cellulose based products | | |
| 2.5. Course content (syllabus) | Development of wood fibres and paper technology. The quality of wood fibres depending on the wood species. Technological processes of wood delignification. Impact of basic and modified methods of delignification on the quality of wood fibres. Thermo-mechanical and chemi-thermo-mechanical pulping. Defibration procedures and their impact on the quality of ground wood.<br>Technological processes of producing semi-cellulose. Neutral sulphite pulping. Cold alkaline pulping.<br>Technological processes of sulphite cellulose. Comparison of sulphite and natrone procedures. Comparison of discontinuous and continuous methods of cooking chips. Influence of white liquor composition and technological parameters on defibration efficiency. Methods and procedures of fibres bleaching. Wood fibres quality insurance. Influential efficiency factors of black liquor regeneration. Technological processes for production of recycled fibers. Nano- cellulose production technologies.<br>Wet-end and dry-end parts of paper manufacturing technology. Paper surface protection and pigment coating methods. Paperboard and cardboard technologies. Paperboard and cardboard surface treatment, dispersion and extrusion protection and lamination methods. Mechanical and electronic printing methods. Technological processes control and paper | | |

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|---|---|---|---|---|---|---|---|---|---|
| | quality insurance. Technological processes development in paper manufacturing. Methods of improving the properties of paper and fibre based products. Ecological aspects of cellulose and paper industry. Guidelines for the development of production technologies. | | | | | | | | |
| 2.6. Format of instruction | ☐ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☒ field work | | | ☐ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other) | | | 2.7. Comments: | | |
| 2.8. Monitoring student work | Class attendance | YES | | Research | | | Oral exam | YES | |
| | Experimental work | | | Report | | | (other) | | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | | | Practical work | | | (other) | | |
| | Project | | | Written exam | YES | | ECTS credits (total) | 4 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | Regular attendance and active participation in lectures, exercises and fieldwork. Taking exam. | | | | | | | | |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | Holik, H. (Ed.): Handbook of Paper and Bord. WILEY-VCH, Weinheim, 2006. | NO | YES |
| | Ćorlukić, F.: Technology of Paper. Školska knjiga, Zagreb, 1987. [In Croatian]. | NO | YES |
| | Španić, N., Jambreković, V., Antonović, A.: Tchnology of Wood Fibres, (Internal script), Faculty of Forestry, Zagreb, 2021. (in writing) | NO | YES |
| 2.12. Optional literature | 1. Kljajić, F.: Chemical Pulping. Školska knjiga, Zagreb, 2000. [In Croatian].<br>2. Sjöström, E., Alén, R. (Eds.): Analytical methods in Wood Chemistry, Pulping, and Papermaking. Springer, Berlin Heilderberg, 1999. | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Stjepan Pervan, PhD<br>Assist. Prof. Miljenko Klarić, PhD. | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Special Technology of Wood Drying | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |
| 1.3. Course code | 235722 | 1.9. Expected enrolment in the course | 10 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |

| | | | |
|---|---|---|---|
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |

| 2. COURSE DESCRIPTION | |
|---|---|
| 2.1. Course objectives | The aim of the course is to train experts - specialists for independent research, development and application work, monitoring, control, analysis and adaptation of all less used non-standard technologies for drying solid wood. |
| 2.2. Enrolment requirements and/or entry competences required for the course | Yes, competencies: Basic knowledge of wood anatomy, wood chemistry, basic properties of wood and wood drying. |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C2 - Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood,<br>wood protection, technology of veneer and wooden board manufacturing, technology of products for<br>building purposes, furniture and other wood products, and guide processes of wood and wooden<br>products finishing, |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Knowledge of the unconventional special technologies for drying of wood.<br>2. Apply and conduct unconventional wood drying procedures.<br>3. Evaluate and select the appropriate level of special drying technology according to production requirements. |
| 2.5. Course content (syllabus) | Physical basics of special methods of wood drying - drying by EM waves, convection drying, drying at reduced air pressure, vacuum drying - technological versions, condensing drying - technological versions, vacuum-pressure process - technological versions, HF and RF drying - technological versions, microwave drying - technological designs, IR radiation drying, drying in liquids, drying with directly heated gases, drying of lamellas, measurement of drying parameters in special drying methods, drying schedules of special wood drying methods, modification of special wood drying schedules, wood drying defects in special drying methods, advantages and disadvantages of special drying methods, selection of technology, calculations and costs of special drying methods. |

| 2.6. Format of instruction | | | 2.7. Comments: |
|---|---|---|---|
| | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☐ field work | ☒ independent assignments<br>☒ multimedia and the internet<br>☐ laboratory<br>☒ work with mentor<br>☐ (other) | |

| 2.8. Monitoring student work | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Class attendance | YES | | Research | | | Oral exam | | |
| | Experimental work | | | Report | | | (other) | | |
| | Essay | | | Seminar paper | YES | | (other) | | |
| | Preliminary exam | YES | | Practical work | | | (other) | | |
| | Project | | | Written exam | YES | | ECTS credits (total) | 4 | |

| | |
|---|---|
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. |
| 2.10. Student responsibilities | |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | Pervan, S.: Internal manuscript for Special wood drying methods | NO | Yes, pdf file available |
| | Pervan, S. (2000): Priručnik za tehničko sušenje drva. 272 str. | YES | NO |
| 2.12. Optional literature | | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assoc. Prof. Goran Mihulja, PhD. | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Multi-axial Woodworking | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |
| 1.3. Course code | 235723 | 1.9. Expected enrolment in the course | 10 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| **2. COURSE DESCRIPTION** | | | |
| 2.1. Course objectives | The aim of the course is to acquaint students with the application of 3D strategies and multi-axial woodworking with CNC machines. Students will gain knowledge of CNC machine programming and their application for performing 3D strategies and multi-axial woodworking. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | Adopted learning outcomes of CNC techniques in woodworking | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C2—Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing,<br>C5—Choose and apply the CNC technique in final wood treatment, | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Explain the possibilities of applying 3D strategies and multi-axial processing on wood products<br>2. Plan the optimal way of using the CNC machining center for production using 3D strategies and multi-axal machining<br>3. Introduce solids and surfaces as well as to create or/and to shape irregular surfaces using simple geometric shapes in CAM software<br>4. Plan the use of arbitrary planes, spline and polyline lines and the extraction and projection of shapes and lines for processing in 3D enviroment.<br>5. Design the sequence of operations for processing product elements with 3D strategies and multi-axial woodworking<br>6. Design the optimal way of fixing complex workpiece shape on the CNC machining center | | |
| 2.5. Course content (syllabus) | Application of 3D strategies and multi-axial woodworking in the production of wood product elements. Possibilities and limitations of production using 3D strategies and multi-axial woodworking. | | |

| | | | |
|---|---|---|---|
| | Software for the preparation of 3D strategies and multi-axial woodworking. Process selection and machining sequence of processing in multi-axis systems. Fixing complex product shapes to the machining centre<br>Irregular surfaces, polygonized and mathematically shaped solids. Arbitrary planes as a tool for positioning of woodworking.<br>Projecting shapes as a basis for defining tool paths on irregular surfaces. Extractions and projections of shapes as a basis for defining tool paths on solids.<br>Setting tool paths based on spline and polyline lines.<br>Selection of tools and definition of machining parameters on surfaces and solids. Use of aggregates in multi-axial woodworking.<br>Woodworking on 3D digitized / polygonized forms.<br><br>Lectures<br>1. Types of surfaces and shapes on which 3D strategies are implemented and their modelling with CAM software<br>2. Types of surfaces and shapes on which multi-axial machining is performed and their modelling with CAM software<br>3. 3D woodworking strategies in DI production<br>4. Construction determinants of machining centers for multi-axial woodworking<br>5. Ways of importing models of complex shapes and their positioning for optimal processing possibilities<br>6. Tool types and tool clamping chucks for woodworking in systems with the possibility of implementing 3D strategies and multi-axial woodworking<br>7. Challenges of tool selection and definition of machining parameters in the application of 3D strategies in the CNC technology-based production<br>8. Challenges of tool selection and definition of machining parameters in the application of multi-axis machining in CNC technology-based production<br>9. Fixing complex product shapes on the machining center<br>10. Selection and sequence of machining operations in multi-axial woodworking<br>11. Arbitrary planes as a tool for positioning of wood processing<br>12. Projecting of shapes as a basis for defining tool paths on irregular surfaces<br>13. Extractions and projections of shapes as a basis for defining tool paths on solids<br>14. Setting the tool path based on splines and polylines<br>15. Use of aggregate fasteners in multi-axial machining<br><br>Exercises<br>1. Design surfaces by CAM software based on contour and extrusion on arbitrary planes<br>2. Design surfaces by CAM software based on directional curve and / or cross-sectional contour<br>3. Design irregular surfaces with CAM software based on boundary curves<br>4. Design surfaces with CAM software based on curve rotation and displacement, stretching, and rounding of surfaces<br>5. Reform surfaces with CAM software based on filling, cutting, enlarging / reducing, and mapping surfaces<br>6. Importing models of complex shapes and their positioning for optimal processing possibilities<br>7. and 8. Execution of 3D processing strategies on loaded / prepared models<br>9. Determining the type, installation method and positioning of the fasteners for fixing complex product shapes to the machining center<br>10. Processing using "pockets" with islands<br>11. Peripheral trimming on a curved surface and between two lines/surfaces<br>12. and 13. Determining the tool path by projecting contours on surfaces and shapes<br>14. Setting up the tool path based on splines and polylines<br>15. Setting up the multi-axial processing using aggregate fasteners | | |
| 2.6. Format of instruction | ☒ lectures | ☒ independent | 2.7. Comments: |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☒ field work | | | assignments<br>☒ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other) | | | | | |
| 2.8. Monitoring student work | Class attendance | YES | | Research | | | Oral exam | YES | |
| | Experimental work | | | Report | YES | | (other) | | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | YES | | Practical work | YES | | (other) | | |
| | Project | YES | | Written exam | YES | | ECTS credits (total) | 4 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | | | | | | | | | |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | Madison, J.: CNC MACHINING HANDBOOK, Ind. press INC. 1996. | | |
| | Irons, I.: Learn CNC Secrets; Quickly Learn the Basic Concepts of CNC, FistFire Publishing Hobart, WA FistFire LLC, 2007, str.1-142. | | |
| | Vindšnurer, D.: NC in CNC v lesarstvu, Ljubljana,1988. | | |

| 2.12. Optional literature | 1. Franjo Nađ dipl.ing.: Priručnik za programiranje, upotrebu i održavanje obradnog centra TECH 80, str.1-25<br>2. Laika, A.: Programmieren von CNC Holzearbeitungmaschinen, Rosenheim, 1991.<br>3. Gegg, B.C., Suh, C.S., Luo, A.C.J.: Machine Tool Vibrations and Cutting Dynamics, Springer, New York, 2011 (DOI https://doi.org/10.1007/978-1-4419-9801-9)<br>4. Csanady, E., Magoss, E.: Mechanics of Wood Machining, Springer, Berlin, Heidelberg, 2013 (DOI https://doi.org/10.1007/978-3-642-29955-1) |
|---|---|

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assist. Prof. Branimir Šafran PhD<br>Assist. Prof. Kristijan Radmanović, PhD<br>Marko Rastija, mag. ing. mech. | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Wood industry power supply | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+0 |
| 1.3. Course code | 33678 | 1.9. Expected enrolment in the course | 15 |

| | | | |
|---|---|---|---|
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 1. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | The scope of acquiring knowledge, skills and patterns for correct and optimum use of energy, as well as identifying and solving energy issues in wood industry. Apart from this, within the programm framework, the skill will be developed required for performing the practical side of this activity by use of control measurement, calculations, testing. etc. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A3 - Apply simpler methods of operation research.<br>B2 - Apply scientific insights on wood as a renewable material and optimise wood usage through the aplication of techniques and technologies for reuse of wood excess. | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Introduce the importance of using heat energy in woodworking processes<br>2. Calculate the savings of electricity when using a motor with frequency and voltage regulation<br>3. Create a plan for selecting hydraulic and pneumatic systems in the wood industry<br>4. Predict the amount of wood residue that is generated in the wood processing industry by machining<br>5. Prepare a report on the advantages and disadvantages of the steam turbine Stirling facility for a selected woodworking plant in relation to the existing<br>6. Design a system for the production of thermal energy for the needs of the technological process on the basis of current consumers as well as planned in the strategic development<br>7. Present and explain the costs of investment and profits in the production of densified wood from most commonly croatian hardwood<br>8. Improve the method of disposal of ash produced during combustion of biomass<br>9. Submit the technical, economic and environmental protection report - the reason for using a flue gas purification filters | | |
| 2.5. Course content (syllabus) | Introduction to wood industry power suply. Definition of basic concepts related to energy and power supply in wood industry. Energy forms and carriers. Accumulated, transition, primary, transformed and useful forms of energy.<br>Electrotermic in wood industry. Direct and indirect heating with electric resistance, IR radiation and electrical indution. Heating with dielectric losses, high frequency and low frequency heating. High-frequency generators.<br>Power plants in wood industry. Energy characteristics. Load and electric power consumption diagrams in WI plants. Appropriate thermal power plants for wood industry.<br>Electric power system. Electro energetic systems. The advantages of connecting the power plants. The energy and power requirements of the electrical energy system. Determining the need and construction of new power plants. Frequency and voltage regulation in the system.<br>Electric motor drives (EMD) in wood industry. Types of electro motors and their features. EMD set. Dinamic state of EMD. Selection of electric motor for the EMD's in wood industry. Rationalization of energy consumption on the electrical equipment and devices in wood industry. Application of mechanical power in woodworking plants.<br>Hydraulic and pneumatic drives. Preparation of medium. Elements of hydraulic and pneumatic drives and their application in wood industry.<br>Forest biomass as an energy source in WI plants. Balance of available wood residues in sawmill production and final wood processing and its use in bioenergy production. Biomass combustion. Boiler equipment in the wood industry plants (preparation of biomass, biomass transport system, stokehole ...). | | |

<table>
<tr><td></td><td colspan="9">Working principles of steam piston motors, Stirling motors, gas and steam turbines. Gasification. Simultaneous production of heat and electricity in WI plants. Efficiency of plants that use biomass as an energy source. Economic indicators of the use of biomass as energy source.<br>Application of thermal energy for devices and heating. Heat transfer and heat exchanger. Heating by: saturated steam, warm and hot water, hot oil and hot air.<br>Heat recuperation in wood industry plants.<br>Energy production in wood industry plants. Rational energy production and consumption in WI. Real energy systems in wood industry.<br>Energy issues of typical wood industry technologies. Characteristic energy transfer in wood industry plants. Briquettes and pellets - energy and economic analysis.<br>Ecology and energy. Waste water. Chimney gases. Ash. Sludge. Technical and other procedures for pollution reducing. Norms and standards.<br>The state and trends of using renewable energy sources in the EU and Croatia. Renewable energy sources laws. Biorafineries and cascade use of forest biomass. Systems for the use of forest biomass in combination with other sources of energy</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☐ seminars and workshops<br>☐ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td>YES</td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td>YES</td><td></td><td>Report</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td>YES</td><td></td><td>Practical work</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>4</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9">Regular attendance and active participation in lectures and exercises. Passing on partial exams and final exams.</td></tr>
<tr><td>2.11. Required literature (available in the library and/or via other media)</td><td colspan="3">Title</td><td colspan="3">Availability in the library</td><td colspan="3">Availability via other media</td></tr>
<tr><td></td><td colspan="3">Hamm, Đ. 1980: Energetika drvne industrije, Šumarska enciklopedija, LZ. “Miroslav Krleža”, Zagreb.</td><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td></td><td colspan="3">Požar, H. 1992: Osnove energetike I, Školska knjiga, Zagreb.</td><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td></td><td colspan="3">Požar, H. 1988: Osnove energetike II, Školska knjiga, Zagreb</td><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td></td><td colspan="3">Požar, H.1992: Osnove energetike III, Školska knjiga, Zagreb</td><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td></td><td colspan="3">Čikič, A.: Doprinos racionalizaciji korištenja toplinske energije u drvnoj industriji, magistarski rad, Fakultet strojarstva i brodogradnje, Zagreb, 1992.</td><td colspan="3"></td><td colspan="3"></td></tr>
</table>

| | |
|---|---|
| 2.12. Optional literature | 1. Loo van S., Koppejan, J. 2002: Handbook of Biomass Combustion and Co-Firing, Twente University Press, Enschede.<br>2. Kaltschmitt, M., Hartmann, H. 2001: Energy aus Biomasse – Grundlagen, Techniken und Verfahren, Springer (Berlin ....Tokio).<br>3. Figurić M., Risović S. 2003: Šumska biomasa, Akademija tehničkih znanosti Hrvatske, Zagreb.<br>4. Matić, M. 1995: Gospodarenje energijom, Školska knjiga, Zagreb.<br>5. Udovičić, B. 2002: Energija i okoliš u globalizaciji, Vlastita naklada, Zagreb.<br>6.Jurković, B. 1990: Elektromotorni pogoni, Školska knjiga, Zagreb. |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Hrvoje Turkulin, PhD<br>Assoc. Prof. Vjekoslav Živković, PhD | 1.7. Number of ECTS credits | 6 |
| 1.2. Course title | Technology of wood building components | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+30+24 |
| 1.3. Course code | 235711 | 1.9. Expected enrolment in the course | 17 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |

| 2. COURSE DESCRIPTION | |
|---|---|
| 2.1. Course objectives | Understanding of the connection between the function, service compliance and technical detailing of particular wood building components: windows, and french doors, entrance doors, panel doors, wooden floors, laminated beams, bridges, houses. Learning about techniques and testing methods for ensuring the quality and production control of wood construction products and building components.<br>Learning and understanding the specific technological operations in manufacture, composition, building, durability provision and maintenance of wood building products. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | B1 - Apply current technical regulations in planning and managing systems, managing production and managing and assuring quality of wood, wooden materials and final products,<br>C2 - Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing,<br>C3 - Design technologies for primary and final wood treatment, develop, improve and optimize production, and apply knowledge from the field of technique and management in the wood industry,<br>C4 - Measure and evaluate quality parameters of wooden products (for building purposes) and interpret their size and meaning. |
| 2.4. Expected learning | 1. Interpretation and evaluation of technological operations for full utilization of wood advantages and reduction of wood shortcomings when used as a construction material, relating wood properties to specific technical requirements for particular construction |

<table>
<tr><td>outcomes at the level of the course (3 to 10 learning outcomes)</td><td colspan="9">product (windows and french doors, panel and entrance doors, flooring elements, wood structures and buildings.<br>2. Definitiion and interpretation of function and technical requirements (serving, lightenting, ventilation, mechanical requirements) as well as basics of building physics: descrtiption and interpretation of acoustic, thermal and hygrotechnical phenomena for wood building components.<br>3. Comparison and evaluation of the function, economic feasibility and technical concept of wood building components.<br>4. Interconnect and interpret the technical design and technology of production of wood building components, formulate and organize the technological process for particular product (production layout and definitiion of operational steps)<br>5. Measure and evaluate technological parameters in the production line and evaluate the fitness of measured properties for particular wood building product (accuracy and smoothness of machined surfaces, wood material properties, glue application rate, pressure, temperature and curing time in gluing, application of coating and curing process of the finish in production of wood building components).<br>6. Define, analyse and evaluate the physical conditions during production and installation of wooden floors, windows and french doors, glulam beams<br>7. Select and interpret the measurement and testing methods for quality control of wood building components and control of production parameters.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td colspan="9">Wooden windows and doors: product types, function, general service requirements (serving, lightening and ventilation). Building physics – technical details in design of acoustic and thermal insulation of windows, doors, walls, floors. Principles of technical design and detailing of the most important types of windows and doors. Processes of small-scale manufacturing and large industrial production processes for windows and doors and wood floorings: choice of machines and equipment, materials, accessories, analysis of specific machining operations. Quality control and testing method for wood building components. Physical and technical aspects of flooring installations.<br>Technical design, detailing and specific production operations in manufacturing of glued laminated beams, bridges, wooden prefabricated houses. Stages in transportation, building, maintenance and restoration.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="4">☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="2">2.7. Comments:</td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td>YES</td><td></td><td>Report</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td></td><td></td><td>Practical work</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td>YES</td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>6</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9"></td></tr>
<tr><td>2.11. Required literature (available in the library and/or via other media)</td><td colspan="4">Title</td><td colspan="2">Availability in the library</td><td colspan="3">Availability via other media</td></tr>
</table>

| | | | |
|---|---|---|---|
| | Turkulin, H.; Ljuljka, B. 1988. Laminated windows and doors, 182 p. Faculty of Forestry, Zagreb | | |
| | Tomašević, J. (1999): Wood in flooring structures. Zagreb: Author's edition | | |
| | Šimetin, V. (1983): Wood physics. Zagreb: Liber | | |
| | Žagar, Z. 2002.Wooden structures. Zagreb: Pretei | | |
| 2.12. Optional literature | 1. Liesse, B. (2002): Holzbauteile. Leinfelden-Echterdingen: DRW-Verlag<br>2. Erler, K. (2002): Holz im im Aussenbereich. Basel-Boston-Berlin: Birkhäuser Verlag<br>3. Pech A, Pommer, G, Zeininger J (2005): Fenster. Springer Wien New York. | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Vlatka Jirouš Rajković, PhD<br>Assist. Prof. Josip Miklečić, PhD | 1.7. Number of ECTS credits | 6 |
| 1.2. Course title | Processes of wood finishing | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+30+16 |
| 1.3. Course code | 235712 | 1.9. Expected enrolment in the course | 20 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | To give students theoretical and practical knowledge that enables him to manage wood finishing department. To acquaint students with technological processes of surface treatment that are in accordance with European regulations, methods of testing the quality of wood finishing and failures that most often occur during process of wood finishing and the methods of their removal. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A2 - Independently gather data, statistically process, present and analyses gathered data, discuss and make conclusions based on analysed data and distinguish the possibilities of different, interpretation of the same problem analysed in different ways,<br>B1 - Apply current technical regulations in planning and managing systems, managing production and managing and assuring quality of wood, wooden materials and final products,<br>C2 - Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing,<br>C4 - Measure and evaluate quality parameters of wooden products (for building purposes) and interpret their size and meaning, | | |

| | |
|---|---|
| | C6 - Enhance existing technologies as well as implement new technologies in the wood industry,<br>C7 - Manage the industrial environment of wood processing and the wooden, chemically protected wood waste and excess.<br>E3 - Gather, process and interpret reference sources and prepare simpler professional or scientific papers. |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1.Distinguish the composition and properties of decorative coatings ("do it yourself") and industrial coatings for wood.<br>2.Explain surface phenomena at the coating-wood interface and connect their influence (wetting, spreading, surface tension, surface energy, penetration coating adhesion)<br>3.Distinguish the adhesion theories and the method of measuring the coating adhesion on the wood and analyze the causes of internal stresses in coatings.<br>4.Recommend materials for finishing of exterior wood products, floors and furniture and design the technological process of building joinery elements (windows) finishing, wood floors finishing and furniture finishing.<br>5.Recommend environmentally friendly technological processes of surface treatment.<br>6.Analyze the causes of failures on the coated wood surfaces<br>7.Use equipment to test the quality of coated surfaces<br>8.Differentiate the test methods for the durability of exterior coatings and examine the durability of exterior coatings for wood.<br>9.Suggest measures for reduction of volatile organic compounds (VOCs) in finishing room.<br>10.Collect information about the professional topic, synthesize and present them. |
| 2.5. Course content (syllabus) | Aesthetic properties of coated wood products. Basics of colorimetry. Composition and properties of wood coating materials. Base of forming the film. Rheological properties of wood finishes. Wood coating interaction: surface energy, wetting and adhesion. Internal stresses in wood coatings. Processes of wood staining. Technological processes of furniture and interiors finishing. Technological processes of building joinery. Processes of finishing with solvent-based wood coatings. Processes of finishing with waterborne wood coatings. Processes of finishing with oils and waxes. Processes of finishing with UV-coatings. Processes of finishing with powder wood coatings. Finishing of exterior wood. Wood and coating properties that affect durability. Wood coatings failures. The causes of failures and methods of eliminating and preventing. The methods of removing old coatings from wood surface and maintenance of exterior wood coatings. Health and environmental protection. Compliant wood coatings. Legislation and perspective in wood finishing sector. Testing the quality of coated wood surfaces. |
| 2.6. Format of instruction | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☒ field work<br>☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☒ work with mentor<br>☐ (other) |
| 2.7. Comments: | |

| 2.8. Monitoring student work | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Class attendance | YES | | Research | | | Oral exam | YES | |
| | Experimental work | YES | | Report | | | (other) | | |
| | Essay | | | Seminar paper | YES | | (other) | | |
| | Preliminary exam | YES | | Practical work | YES | | (other) | | |
| | Project | YES | | Written exam | YES | | ECTS credits (total) | 6 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | | | | | | | | | |

| | | | |
|---|---|---|---|
| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
| | Ljuljka, B., Jirouš-Rajković, V. 2006: Osnove površinske obrade drva. Šumarski fakultet, Sand, 2006. | YES | |
| | Jaić, M.; Živanović-Trbojević, R: Površinska obrada drveta. Izdavač: M. Jaić, Beograd, 2000. | NO | Available in pdf format in the Merlin E-learning platform |
| | Ljuljka, B. 1990: Površinska obrada drva, Sveučilište u Zagrebu, Šumarski fakultet, Zagreb | YES | |
| 2.12. Optional literature | • Bulian, F.; Graystone J.A.: Industrial wood coatings. Theory and Practice. Elsevier, Oxford, UK 2009.<br>• R. Sam Williams: Wood finishing. Source: Wood handbook : wood as an engineering material. Madison, WI : USDA Forest Service, Forest Products Laboratory, 1999. General technical report FPL ; GTR-113: Pages 15.1-15.37<br>https://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr113/ch15.pdf<br>• Reinhold Schwalm: UV Coatings: Basics, Recent Developments and New Applications. Elsevier, 2006.<br>https://issuu.com/emagladiolavalenciamay2/docs/uv_coatings-_basics__recent_develop<br>• Andreas Hänsel; Jorge Prieto: INDUSTRIELLE BESCHICHTUNG VON HOLZ UND HOLZWERKSTOFFEN IM MÖBELBAU. 2019 Carl Hanser Verlag GmbH & Co. KG | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assoc. Prof. Marin Hasan, PhD | 1.7. Number of ECTS credits | 5 |
| 1.2. Course title | Technology of wood protection | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |
| 1.3. Course code | 235713 | 1.9. Expected enrolment in the course | 20 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Following of the quality and soundness of the wood raw material from the beguining (felling trees) to the final product.<br>The recognition of the «mistakes» caused by all causes; the use of methods and preservatives of wood sterilization and protection.<br>The wood waste and recovered wood management, particularly with the wood treated with chemical preservatives. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at | B4: Plan and analyse material handling, solve problems of transport, storage and selection | | |

| | | | |
|---|---|---|---|
| the level of the programme to which the course contributes | of transport technique, analyse factors influencing the efficiency and expenses of wood and wooden, materials transport and storage.<br>C4: Measure and evaluate quality parameters of wooden products (for building purposes) and interpret their size and meaning,<br>C5: Choose and apply the CNC technique in final wood treatment,<br>D5: Perform the most complex tasks in all types of companies dealing with processing, refinement and wood trade, as well as in consultancy and engineering companies | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Based on the results of laboratory tests, independently determine the biological resistance of wood to the applicable standards and to recommend hazard class in which such wood can be used.<br>2. Assess the risk of using biodegraded wood in the production and / or use of wooden products.<br>3. Explain the difference between decontamination and wood protection procedures and propose the required procedure in the given example.<br>4. Differentiate and define wood preservatives according to the aggregation state, the origin of the active component and the nature of the solvent.<br>5. Propose the appropriate wood preservative and procedure for the given product (in the given hazard class), respecting the ecological principles of wood protection and describe the advantages and disadvantages of the proposed.<br>6. For the selected product and the conditions of use, in which the wood product is used, to recommend adequate physical, structural (and chemical) protection.<br>7. Recommend steps of restoration, adequate preventive or repressive protection procedures and choose adequate protective agent(s) depending on the type of wood product(s), the place of use and the degree of destruction.<br>8. Distinguish modified wood from natural and explain their advantages and disadvantages.<br>9. When designing new products from wood to anticipate the conditions of its use and possible mechanisms of degradation and to choose wood with needed natural resistance and to the recommend needed protection.<br>10. Independently or in a team develop a project (expert opinion) and present it in front of a group of people. | | |
| 2.5. Course content (syllabus) | The latest scientific knowledge on wood protection (new protection procedures and wood preservatives).<br>Traditional methods in the aim of the monitoring and controlling of wood health.<br>Methods of preventive protection of wood and wooden products during wood processing (storage, sawmills, wood drying processes, wood processing, wood finishing, the storage of final products). Application of novel environmentally friendly preservatives and methods in the wood preservation, especially regarding to soil, water and air protection.<br>Wood modifications (natural and artificial, fossilization, petrifying, active and passive, chemical, thermal and enzymatic modification, esterification, etherification, acetylation, wood heating processes without air, heating in oils, physical modification, ...).<br>Lectures and exercises at the Faculty and out of the Faculty (new and ancient wooden objects (constructions), museums, churches, restoration workshops, wood processing plants).<br>Learning on wood decontamination and repressive protection of wooden objects and objects of cultural heritage, 'anoxi' procedures.<br>Wood waste and recovered wood, possibility of reconstruction and reuse of old preservative treated wood, wood waste and residues from chemically protected wood (old poles and sleepers, thresholds, wooden elements of building constructions, old wooden buildings, old wooden joinery).<br>Classification, deponiing, recycling and reuse of products from chemically protected wood which „life cycle“ is formaly finished.<br>Phytosanitary sterilization (importance of sterilization of wooden packaging in international trade). | | |
| 2.6. Format of instruction | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety* | ☒ independent assignments<br>☐ multimedia and the internet | 2.7. Comments: |

<table>
<tr><td></td><td colspan="3">☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ laboratory<br>☒ work with mentor<br>☐ (other)</td><td colspan="3"></td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td>YES</td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td>YES</td><td></td><td>Report</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td>YES</td><td></td><td>Practical work</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td>YES</td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>5</td><td></td></tr>
<tr><td></td><td colspan="9"></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9"></td></tr>
<tr><td rowspan="7">2.11. Required literature (available in the library and/or via other media)</td><td colspan="5">Title</td><td colspan="2">Availability in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="5">Glavaš, M. 1999: GLJIVIČNE BOLESTI ŠUMSKOG DRVEĆA. Sveučilište u Zagrebu, Šumarski fakultet. Sveučilišni udžbenik, 1999.</td><td colspan="2">YES</td><td></td></tr>
<tr><td colspan="5">Špoljarić, Z. 1973: ZAŠTITA DRVA (Impregnacija). Šumarski fakultet Zagreb, 1973.</td><td colspan="2">YES</td><td></td></tr>
<tr><td colspan="5">Hasan, M., Despot, R. 2018: Zaštita drva I, Abiološki čimbenici, lignikolne bakterije i gljive, ksilofagni kukci i morski štetnici – skripta za studente drvne tehnologije iz predmeta Zaštita drva I i Patologija drva. Sveučilište u Zagrebu, Šumarski fakultet, Zagreb, 2018.</td><td colspan="2">NO</td><td></td></tr>
<tr><td colspan="5">Reinprecht, L. 2001: PROCESY DEGRADACIE DREVA. Tehnicka Univerziteta vo Zvolene, Zvolen, 2001. (selected chapters).</td><td colspan="2"></td><td></td></tr>
<tr><td colspan="5">Proceednigs from the international conferences WOOD IN THE CONSTRUCTION INDUSTRY. (DESPOT, r., Jambreković, V. Editors). Faculty of Forestry Zagreb. (editions from 2000 to 2004).</td><td colspan="2">YES</td><td></td></tr>
<tr><td colspan="9"></td></tr>
<tr><td>2.12. Optional literature</td><td colspan="9">Salminen, E., Valo, R., Korhonen, M., Jernlås, R. 2014: Wood preservation with chemicals Best Available Techniques (BAT). TemaNord 2014:550 ISSN 0908-6692. Nordic Council of Ministers 2014. ISBN: 978-92-893-2828-9, ISBN 978-92-893-2829-6 (EPUB).<br>Unger, A., Schniewind, A.P., Unger, W. 2001: CONSERVATION OF WOOD ARTIFACTS, Springer, 2001.<br>Richardson, B.A. 1993: WOOD PRESERVATION second edition, E & FN SPON, London, 1993.<br>Eaton, R.A., Hale, M.D.C.1994: WOOD, DECAY, PESTS AND PROTECTION, Chapman & Hall, 1994. United Kingdom.<br>Bravery, A.F., Berry, R.W., Carey, J.K., Cooper, D.E. 1992: RECOGNISING WOOD ROT AND INSECT DAMAGE IN BUILDINGS, BRE Bookshop, Seconfd edition, 1992. Garston, Watford, United Kingdom.<br>Reinprecht, L. 2000: REKONŠTRUKCIA OBJEKTOV Z DREVA, Monografia, Technicka Univerziteta vo Zvolene, Zvolen, 2000.</td></tr>
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| | Zbornici radova sa međunarodnih IRG-WP konferencija: International Research Group on Wood Protection, IRG-WP Stockholm, Sweeden. (izdanja od 1990. do 2020.) |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Anamarija Jazbec, PhD<br>Assist. Prof. Azra Tafro, PhD | 1.7. Number of ECTS credits | 5 |
| 1.2. Course title | Applied Statistics | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+0 |
| 1.3. Course code | 235714 | 1.9. Expected enrolment in the course | 15 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 3. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | The objective of the course is to introduce and train students to independently collect, statistically analyse and display the collected data. To enable students to discuss and reach conclusions based on analysed data. Independently analysed and write a report on obtaining the standard for a product. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A2-Independently gather dana, statitically process, present and analyses gathered dana, discuss and make conclusions based on analysed dana and distinguish the possibilities of different, interpretation of the same problem anaylsed in different ways. | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1.Identify, implement and perform a statistical test based on sample for testing population mean and proportion<br>2.Identify, implement and perform a statistical test based on sample for testing population variance.<br>3.Identify, implement and perform a statistical test for testing difference between two population proportions (test of proportions)<br>4.Identify, implement and perform a statistical test for testing difference between two population variances (F test)<br>5.Identify, implement and perform a statistical test for testing difference between two population means (t test, Mann Whitney test)<br>6.Identify, implement and perform a statistical test for testing equality more than two population means (ANOVA)<br>7.Identify, implement and perform a statistical test for testing two dependent population means (t paired test)<br>8.Calculate population correlation and estimate coeficient of the correlation and preforme statistical test (Pearson's and Spearman rank correlations) with computer support..<br>9.Analyze and interpret the results of univariate and multivariate linear regression with the help of computer support.<br>10.Analyze the contingency table implement the chi2 test | | |
| 2.5. Course content (syllabus) | Statistical decision theory, Hypotheses Testing. Testing for the Population Mean. Testing Population Proportion. Testing Population Variance. Difference between two Population | | |

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|---|---|
| | Proportions. Difference between two Population Variances. Difference between two Population Means. T-test. Nonparametric Mann Whitney test. Analysis of Variance. Perason`s and Spearman rank Correlation. Linear Regression. Least Squares Mathod. Estimation of Regression Coefficients.Coefficient of Determination. Model building. Methods of Model building. Univariat and Multivariate Regression Models. Modelling Interactions. Chi square test. |

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|---|---|---|---|
| 2.6. Format of instruction | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☐ field work | ☐ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other) | 2.7. Comments:<br>Exercises are performed computationally and on computers using a statistical computer program. |

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|---|---|---|---|---|---|---|---|---|
| 2.8. Monitoring student work | Class attendance | YES | | Research | | | Oral exam | YES | |
| | Experimental work | | | Report | | | (other) | | |
| | Essay | | | Seminar paper | YES | | (other) | | |
| | Preliminary exam | YES | | Practical work | | | (other) | | |
| | Project | | | Written exam | YES | | ECTS credits (total) | 5 | |

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|---|---|
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. |
| 2.10. Student responsibilities | Regular attendance and active participation in lectures and exercises. Self-learning and solving exercises outside regular classes. Preapering, attending and passing two partial exams and, if necessary, final exam. |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | Jazbec A. Applied Statistics (in Croatian) Internal script | NO | YES. All teaching materials in written and same in video form are on the Merlin platform |
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|---|---|
| 2.12. Optional literature | 1. Jazbec A. (2009) Osnove statistike, 2 ed. Šumarski fakultet, Zagreb<br>2. Bahovec V, Erjavec N ur. (2015) Statistika, Element, Zagreb<br>2. Montgomery D.C.(2005) Statistical Quality Control, 5ed. Wiley, NewYork |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Tomislav Poršinsky, PhD<br>Assist. Prof. Andreja Đuka, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Timber harvesting | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |

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|---|---|---|---|
| 1.3. Course code | 235726 | 1.9. Expected enrolment in the course | 15 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | The topic of the subject is oriented to the ideas necessary for the educational profile, and they primarily refer to the knowledge of forest products of roundwood, which are a raw material base for the wood processing and methods and characteristics of techniques and technologies of their obtaining and transport to the wood processing plants. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | B2 - Apply scientific insights on wood as a renewable material and optimise wood usage through the application of techniques and technologies for reuse of wood excess.<br>B4 - Plan and analyse material handling, solve problems of transport, storage and selection of transport technique, analyse factors influencing the efficiency and expenses of wood and wooden, materials transport and storage.<br>C4 - Measure and evaluate quality parameters of wooden products (for building purposes) and interpret their size and meaning.<br>C6 - Enhance existing technologies as well as implement new technologies in the wood industry.<br>D1 - Recommend resource usage through the management of a process which consists of planning, organizing, directing and controlling.<br>D2 - Perform tasks in the field of industrial management in wood refinement and furniture manufacturing, micro planning, assignment distribution, optimization of manufacturing decisions, production management and work control. | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. To differentiate and correlate the limiting and influential factors of the forest utilisation in the environment (legal restrictions, proprietary relationships, terrain and stand characteristics and link the theory and procedures in tree felling: finding the tree marked for felling, determine the felling direction, prepare the surrounding environment, shape the butt swelling, create and control the cuts, place cutting wedges and guide the tree to the fall, release blocked trees. Explain the concept of tree cutting, the mechanisation level in tree cutting, working with the motor chainsaw in different conditions.<br>2. Differentiate between methods of timber processing and connecting them with terrain characteristics and vehicle types, cutting branches, measuring assortments and bucking, scaling and pilling forest residue and analyse and compare old HRN-JUS and new HRN-EN standards for round wood of broadleaved species and conifers.<br>3. Compare mechanised tree felling and processing with motor-manual felling (pros and cons of harvesters, limitations, productivity, factors of efficiency and environmental benefits, mechanised felling in Croatia).<br>4. Compare and link the theoretical approach and division of timber transport: collecting, extracting and long distance transport, timber transport cycles, the basic parameters of forest accessibility through: road density, the distance between forest roads and the average extraction distance and calculate the optimal distance between forest roads, the dependence of the distance between forest roads on costs based on the theoretical model for determining optimal forest accessibility, the calculation of the costs of forest road construction and the costs of timber extraction.<br>5. Evaluate ground-based timber extraction systems with regard to mechanisation level (manual, animal or mechanised system) and evaluate the features, limitations and benefits of individual vehicles (adopted agricultural tractor, tractor with trailer, cable skidder, grapple skidder, clam-bunk skidder, forwarder, rigid and flexible tracks skidder). Calculate the cost of machine work and productivity of the system. | | |

<table>
<tr><td></td><td colspan="9">6. Evaluate the aerial timber extraction systems – forest skyline and helicopter. Assess the suitability of both systems with respect to stand conditions and environmental acceptability. Distinguish the features of the highlead and forest skyline, analyse the characteristics of forest skylines considering the direction of timber extraction, the number of lines, mobility of the skyline, length of yarding corridor, payload and mobility of the system. Re-examine the application of helicopters, efficiency factors, requirements for landing sites and helipads, noise pollution.<br>7. Explain the division and features of the long distance timber transport, the types of landing sites, the characteristics of the timber transport by waterways, railway, trucks and calculate costs of long distance truck transport, analyse the factors affecting the transport in the form of legal restrictions in public transport, features and characteristics of trucks and load.<br>8. Re-examine the utilisation of forest biomass through the analysis of fuel wood as a traditional energy supplier compared to other energy sources. Valorise the features of forest biomass for energy, influential factors of the utilisation technologies for forest biomass.<br>9. Compare the systems and benefits of forest biomass utilisation: chipping, chipping on landing sites – open and closed production chain, bundling, biomass from short-rotation cultures, chipping in the plant and compare forest utilisation systems in Croatian forestry and worldwide (system definitions and models – mathematical model Löffler (1989), theory of production systems simulation (Heiniman (2003)).<br>10. Examine the environmental suitability of timber harvesting systems regarding stand damage and pollution (soil, water, standing trees, young growth). Identify the causes of damage and pollution and select the measures for their avoidance or reduction. Differentiate the level of planning operation in forest utilisation (from strategic to operational level – harvesting plan and working-site study).</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td colspan="9">Lectures include following units: Introduction to logging – scope and goal; Limiting factors in logging (social, terrain, stand, customer position, 5E criteria); Felling (cutting) of trees with a chain saw; Processing of timber with a chain saw; Mechanised felling and processing; Introduction to timber transport and forest accessibility indicators; Manual, animal and mechanised timber extraction; Timber extraction with forestry vehicles; Aerial timber extraction with forest skyline and helicopters; Long distance timber transport by trucks; Long distance timber transport by railway and waterway; Obtaining forest biomass for energy; Causes and consequences of stand and habitat damage due to harvesting operations; Measures to reduce stand and habitat damage due to harvesting operations; Harvesting systems. While practical lessons are structurally divided into units follwing lectures: Timber measurement, Wood defects I (irregularities of round wood, irregularities in anatomy), Wood defects II (irregularities due to physical-mechanical factors, change in colour and consistency of timber, defects due to insects); Classification of deciduous and coniferous wood by purpose (JUS); Classification of deciduous and coniferous wood by quality (EN); Evaluation of the standing tree; Calculation of the Logging Plan; Components of the Work Study Site; Determining the optimal distance between forest roads; Costs and productivity of skidding timber; Costs and productivity of timber forwarding; Analysis of the performance and costs of long distance timber transport by trucks; Preparation for fieldwork measurements “Utilisation of timber in felling and processing of pedunculate oak"; Processing of data from fieldwork measurements; Analysis of results obtained in the fieldwork measurements.<br>Students acquire practical skills through fieldwork measurements "Utilisation of timber in felling and processing of pedunculate oak."</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☐ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td>2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
</table>

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Experimental work | | | Report | YES | | (other) | | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | YES | | Practical work | YES | | (other) | | |
| | Project | | | Written exam | YES | | ECTS credits (total) | 4 | |

| | | | |
|---|---|---|---|
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | |
| 2.10. Student responsibilities | Regular attendance and active participation in lectures and exercises. Passing on partial exams and final exams. | | |
| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
| | Poršinsky, T., Đuka, A.: Presentations of lectures, practical lessons – excercises and preparation materials for fieldwork measurements from the course Logging I. | NO | YES, Merlin |
| | Zečić, Ž., Vusić, D., 2020: Katalog drvnih šumskih proizvoda. Faculty of Forestry Zagreb, 1–182. | YES | |
| 2.12. Optional literature | 1. MacDonald, AJ., 1999: Harvesting Systems and Equipment in British Columbia. FERIC, Handbook No., HB-12: 1-197.<br>2.Sessions, J., 2007: Harvesting operations in the tropics. Springer-Verlag, Berlin, Heidelberg, 1-170.<br>3.Längin, D., Ackerman, P., Krieg, B., Immelmann, A., Potgieter, C.,van Rooyen, J., Upfold, S., 2010: South African Ground Based Harvesting Handbook. Forest Engineering Southern Africa and Institute for Commercial Forestry Research, Scottsville, South Africa, 1-182.<br>4.Krpan, A.P.B., Poršinsky, T., 2002: Productivity of Timberjack 1070 Harvester in Scotch Pine Thinning. Šumarski list 126(11-12):551-561.<br>5.Poršinsky, T., Stankić, I., 2005: A contribution to understanding timber yarding by forest skylines. Nova meh. šumar. 26: 39-54.<br>6.Sabo, A., Poršinsky, T., 2005: Skidding of fir roundwood by Timberjack 240C from selective forests of Gorski Kotar. Croat. j. for. eng. 26(1): 13-27.<br>7.Prka, M., Poršinsky, T., 2009: Structure comparison oftechnical roundwood i neven-aged beech cutblocks by assortment tables with application of standards HRN (1995) and HRN EN 1316-1: 1999. Šum. list 133(1-2): 15-25.<br>8.Poršinsky, T., Stankić, I., Bosner, A., 2011: Ecoefficient Timber Forwarding Based on Nominal Ground Pressure Analysis. Croat. j. for. eng. 31(1): 345-356.<br>9.Stankić, I., Poršinsky, T., Tomašić, Ž., Tonković, I., Frntić, M., 2012: Productivity Models for Operational Planning of Timber Forwarding in Croatia. Croat. j. for. eng. 33(1): 61-78.<br>10.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.<br>11.Poršinsky, T., Đuka, A., Papa, I., Bumber, Z., Janeš, D., Tomašić, Ž., Pentek, T., 2017: Criteria for determining primary forest traffic infrastructure network density – examples of the most common cases. Šum. list 141(11-12): 593-608.<br>12. Poršinsky, T., Petreković, V., Đuka., A., 2020: Bark Thickness of Wild Cherry in Timber Scaling. Šum. list 144(1-2): 7-14. | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assist. Prof. Kristina Klarić, PhD<br>Assoc. Prof. Krešimir Greger, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Quality management and assurance | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |
| 1.3. Course code | 235735 | 1.9. Expected enrolment in the course | 20 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |

| 2. COURSE DESCRIPTION | |
|---|---|
| 2.1. Course objectives | The aim of the course is to enable students to solve problems of quality management and quality assurance. Students gain the ability to apply and evaluate general and specific knowledge in the field of quality management and quality assurance tailored to specific production problems in wood processing and furniture production. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A1 - Explain the position and trends of the wood industry in the country and worldwide,<br>A2 -Independently gather data, statistically process, present and analyses gathered data, discuss and make conclusions based on analysed data and distinguish the possibilities of different, interpretation of the same problem analysed in different ways,<br>B1 - Apply current technical regulations in planning and managing systems, managing production and managing and assuring quality of wood, wooden materials and final products,<br>D1 - Recommend resource usage through the management of a process which consists of planning, organizing, directing and controlling,<br>D2 - Perform tasks in the field of industrial management in wood refinement and furniture manufacturing, micro planning, assignment distribution, optimization of manufacturing decisions, production management and work control,<br>D4 - Manage and perform tasks in wood industry entrepreneurship,<br>D5 - Perform the most complex tasks in all types of companies dealing with processing, refinement and wood trade, as well as in consultancy and engineering companies. |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Interpret and understand basic concepts in the field of quality management.<br>2. Distinguish and analyze quality management systems.<br>3. Distinguish and interpret quality management tools, methods and techniques.<br>4. Explain and analyze the quality management system certification and integrated management system.<br>5. Define and explain business excellence models.<br>6. Analyze and distinguish quality indicators, types of quality control and points of quality control.<br>7. Identify and decompose quality costs.<br>8. Select and apply some quality management tools, methods and techniques on specific examples from the wood industry. |
| 2.5. Course content (syllabus) | Introduction. Development of quality awareness. Historical development of quality management. Significant experts and authors in the field of quality - quality gurus. Stages of quality development. Quality control, quality assurance, quality management. Norms and standardization (internal, national, regional and international). Normative determination of quality in wood processing and furniture production. Basic settings / principles of quality |

<table>
<tr><td></td><td colspan="9">management. Quality management systems: Total Quality Management, Six sigma, Lean production, quality standards, other quality management systems and methods. Certified quality management systems. Integrated management systems. Quality management system. Environmental management system. Occupational health and safety management system. Other certification systems. Quality and social responsibility. Business excellence. Business excellence models. Statistical process control. Basic quality management tools. Traditional quality management tools. Quality management methods. Quality management techniques. Quality indicators. Approach to quality from different points of view. Types of quality control. External and internal quality control. Points of quality control in the organization: input quality control, quality control in the production process and quality control of finished products - final control and testing. The impact of quality on business performance. Types of quality costs: costs for quality, costs due to (in) quality. Permeation of quality and production process. Specifics of methods, techniques and tools for management and quality assurance in wood processing and furniture manufacturing companies. Quality management in wood processing and furniture production.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☒ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:<br>If necessary, classes can be conducted entirely online.</td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td></td><td>Report</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td>YES</td><td></td><td>Practical work</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>4</td><td></td></tr>
<tr><td></td><td colspan="9"></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9">Regular attendance and active participation in lectures and exercises, preparation of exercises, preparation and presentation of seminar work. Taking colloquiums, exams.</td></tr>
<tr><td>2.11. Required literature (available in the library and/or via other media)</td><td colspan="5">Title</td><td colspan="2">Availability in the library</td><td>Availability via other media</td></tr>
<tr><td></td><td colspan="5">Figurić, M. 2000: Proizvodni i poslovni procesi u preradi drva i proizvodnji namještaja, Sveučilište u Zagrebu, Šumarski fakultet, Zagreb.</td><td colspan="2">YES</td><td></td></tr>
<tr><td></td><td colspan="5">Lazibat, T.: Upravljanje kvalitetom, Znanstvena knjiga, Zagreb, 2009.</td><td colspan="2">NO</td><td></td></tr>
<tr><td></td><td colspan="5">Greger, K. 2000: Proizvodni i poslovni procesi u preradi drva i proizvodnji namještaja (zbirka zadataka), Sveučilište u Zagrebu, Šumarski fakultet, Zagreb.</td><td colspan="2">YES</td><td></td></tr>
<tr><td>2.12. Optional literature</td><td colspan="9">1. Skoko, H.: Upravljanje kvalitetom, Sinergija d.o.o., Zagreb, 2000.<br>2. Gryna, F., Juran, J.: Planiranje i analiza kvalitete, Mate, Zagreb, 2002.<br>3. Šiško Kuliš, M., Grubišić D.: Upravljanje kvalitetom, Sveučilište u Splitu, Ekonomski fakultet, 2010.<br>4. Štajdohar-Pađen, O., Plivati s ISO-om i ostati živ, Zagreb : Grafički zavod Hrvatske. Zagreb: Kigen, 2009.</td></tr>
</table>

# COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assoc. Prof. Ivica Župčić, PhD<br>Assist. Prof. Josip Miklečić, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Designing wood industry plants | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |
| 1.3. Course code | 235729 | 1.9. Expected enrolment in the course | 10 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Acquiring knowledge and skills about the basic elements of design and to apply the knowledge acquired during the studies to design wood industry plants. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | C3 - Design technologies for primary and final wood treatment, develop, improve and optimize production, and apply knowledge from the field of technique and management in the wood industry. | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. to explain basic concepts of production (material preparation, inner transport, the manufacturing of parts, surface treatment, assembly etc.) and technological (qualitative changes of the input material in the end product) processes in wood and wood panel processing and the manufacture of furniture;<br>2. to distinguish and categorise basic project types (pre-project, preliminary design, investment programme, executive project, the survey of completed works etc.) in the business system;<br>3. to apply the knowledge acquired during the studies from other courses (final wood processing technology, conveyor technology in wood industry, technological processes of the surface treatment of wood etc.) to designing wood industry plants;<br>4. to select machinery, equipment and tools based on the criteria of increased productivity, tool cost reduction, increased machine life cycle (the choice of a suitable processing schedule, proper machinery and tool maintenance) improved product quality, rejects reduction etc.;<br>5. to analyse the production programme, production resources and suppliers for a more rational use of machinery and tools, increased production and reduced manufacture costs;<br>6. to explain and apply basic principles in the approach when building and reconstructing (adapting the technological process to science and technology development) wood industry plants in relation to the proper use of new equipment, production volume increase and environmental protection;<br>7. to design the work space and working areas in the work industry plant in order to ensure ergonomics (adequate machinery height ), safety at work (noise, protection against dust, smoke, vapour and alike, working area illumination, vibrations etc.) and the proper arrangement of machinery; | | |

<table>
<tr><td></td><td colspan="9">8. to assess and recommend the optimum manner of using existing technology to increase productivity, utilisation and product quality while taking into account market demands (e.g. new product introduction);<br>9. to recommend a suitable technological procedure and wood processing technology based on needs determined by means of an analyses while taking into account the safety of employees, increased machine efficacy and wood and wood panel utilisation;<br>10. to gather, group and process information about the assigned topic and present it.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td colspan="9">Introduction to designing plants in wood industry. Technology and technological systems. Production and technological processes in wood processing. Basic principles in approach when building or reconstructing a plant.<br>Planning investment projects. Types of projects in business systems. Building and reconstruction of manufacturing plants.<br>Production program – basics of the technological process. Analysis of the production program. Structure of products and range (making of documentation and description of documentation).<br>Needs and supply of raw materials. Calculating materials and needs for materials. Reserves of materials, intermediate and finished goods. Analysis of resources and suppliers.<br>Designing technological processes. Methods of designing technological processes. Determining and choosing technology. Criteria (technological, capacity, flexibility, reserves and losses of material, productivity, degree of automation, precision and quality of processing). Organizing space and arrangement of workspace. Defining needs of employees. Inner transport and storage. Production and energy facilities. Macro and micro locations of basic and auxiliary plants. Energy needs and sources. External transport and roads. High and low buildings.<br>Project documents. Project task. Notional – technologic solution and project – study of development. Investment program, main and executive project, survey of completed works.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td></td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td></td><td>Report</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td>YES</td><td></td><td>Practical work</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td>YES</td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>4</td><td></td></tr>
<tr><td></td><td colspan="9"></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9">Regular attendance and active participation in lectures, exercises and field work. Preparations of individual tasks (preparation of documentation) from exercises and field work and writing reports. Pass the preliminary exam and exam.</td></tr>
<tr><td rowspan="2">2.11. Required literature (available in the library and/or via other media)</td><td colspan="4">Title</td><td colspan="2">Availability in the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td colspan="4">Mosch, H.P. 1984: Betriebseinrichtung, Entwurfslehre fuer Projektirung und Rekonstruktion I. VEB Verlag Technik, Berlin.</td><td colspan="2">NO</td><td colspan="2">professors office</td></tr>
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|---|---|---|---|
| | Bogner, A. 2012: Projektiranje drvnoindustrijskih pogona. Interna skripta, Sveučilište u Zagrebu, Šumarski fakultet, Zagreb | NO | MERLIN |
| 2.12. Optional literature | Eckhard, M. 1999: Holztechnik, Grundlagen der CNC-Holzbearbeitung, Verlang Europa-Lehrmittel, Deutschland ,1-109.<br>Rochstroch, W. 1981: Betriebsgestaltung in der Holzindustrie, Leipzig, str. 189-255.<br>Wooldridge, W. J. 1986: Woodturning. Butler & Tanner, London.<br>F. Šef, Ž. Oluji. 1988: Projektiranje procesnih postrojenja, SKTH, KUI, Zagreb.<br>Tkalec, S., Bogner, A. 1983.: Pomoćne radionice u DIP "OGULIN" Idejni projekt, Šumarski fakultet ZIDI. | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Anka Ozana Čavlović, PhD<br>Prof. Ružica Beljo Lučić, PhD<br>Prof. Vlatka Jirouš Rajković, PhD<br>Prof. Vladimir Jambreković, PhD<br>Assoc. Prof. Marin Hasan, PhD<br>Assist. Prof. Nikola Španić, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Protection of industrial environment | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+8 |
| 1.3. Course code | 235730 | 1.9. Expected enrolment in the course | 10 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Students acquire skills required in wood industry environmental management. They are introduced to contamination sources of a working atmosphere, monitoring of emissions, standards and legislation, as well as to ecology engineering and administrative methodology of environmental protection. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | B3: Manage procedures and processes of improving natural wood disadvantages using chemical, physical and enzymatic modifications<br>C1: Apply technological processes of mechanical and thermo-chemical wood refinement in the manufacturing of wood fibers and paper,<br>C2: Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing,<br>C7: Manage the industrial environment of wood processing and the wooden, chemically protected wood waste and excess. | | |

| | | | |
|---|---|---|---|
| | E3: Gather, process and interpret reference sources and prepare simpler professional or scientific papers, | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1.recommend cleaner energy and raw materials, methods, techniques and technologies of wood processing and wood products design according to the 4R principles of cleaner production (reduce, replace, reuse and recycle);<br>2.suggest activities in wood processing companies for implement regulations and norms related to the protection of industrial environment;<br>3.propose and implement legislation on the safety at wood production working places and suggest precautions and protective equipment at the workplace, and opportunities to reduce exposure;<br>4.measure, analyze and evaluate the noise level at the workplace in woodworking, apply the appropriate noise reduction methods, investigate the worker's noise exposure, and apply the optimal methods of protecting the worker from excessive noise;<br>5.interpret the impact of wood processing on the carbon cycle and the issue of greenhouse gases;<br>6.calculate the quantities of pollutants (CO, CO2, NOx, SOx, PM10) from the discharge of wood waste, the amount of carbon dioxide from combustion of fossil fuels used for transport in the production and the amount of accumulated carbon in the wood product;<br>7.to propose and describe the optimal protection technology for a number of protective products for wood products, to anticipate and describe possible human and environmental hazards for the selected protective agent and to propose possible recovery and recycling processes of treated wood products;<br>8.to interpret the problem of wastewater in the production of wood fibers and paper, evaluate the emission of free formaldehyde wood materials;<br>9.distinguish hazardous substances in the wood varnish process and the basic method of purifying air and water in paint shops, design measures to reduce volatile organic compounds in the surface treatment of wood and wood materials and make solvent management plans;<br>10.recommend an integrated environmental management system, quality system and safety at work. | | |
| 2.5. Course content (syllabus) | Cleaner production. Best Available Techniques. EU legal acts and national regulations on integrated environmental protection related to activities in the wood industry. Recycling. Circular economy. Work environment. Worker exposure, emission sources and occupational health. Risks and protection measures at work besides typical places in the wood industry. Noise and vibration. EU legal acts and national regulations on safety at work, fire and explosion protection in the wood industry. Aerosol. Aerodynamic diameter of particles. Diffuse sources of dust emissions. Methods for determination of worker exposure to wood dust. Explosiveness and flammability of wood dust. Holders of environmental protection. General environment. Atmosphere. EU legal acts and national regulations on environmental protection, air protection and sustainable waste management related to wood processing activities. Pollutant. Environmental pollution Register. Solid particle separation methods. Methods of separation from homogeneous gas mixtures. Methods of separation of gaseous pollutants. Annual quantities of pollutants from fossil and biofuel combustion in the wood industry and their calculation (CO, CO2, NOx, SOx, PM10). Waste water and emissions of formaldehyde. Calculation of the annual amount of hazardous pollutants in the consumption of adhesives in the production of wood-based panels (plywood). Surface Treatment of wood products. Preparation of annual solvent balance of wood surface treatment agents. Eco balance of wood products production process. Wood protection. EU legal acts and national regulations related to the use of wood preservatives. Carbon cycle and greenhouse gas emissions. Environmental Management Systems. EMAS, ISO, OHSAS. | | |
| 2.6. Format of instruction | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☒ field work | ☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other) | 2.7. Comments: |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2.8. Monitoring student work | Class attendance | YES | | Research | YES | | Oral exam | YES | |
| | Experimental work | | | Report | | | (other) | | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | | | Practical work | | | (other) | | |
| | Project | | | Written exam | YES | | ECTS credits (total) | 4 | |

| | | | |
|---|---|---|---|
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | |
| 2.10. Student responsibilities | Regular attendance and active participation in lectures and exercises. Taking exam. | | |
| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
| | A.O.Čavlović: Zaštita industrijskog okoliša (Protection of industrial environment), revised teaching material, 2016. | NO | YES https://moodle.srce.hr |
| | Briški, F.: Zaštita okoliša. Sveučilište u Zagrebu, Fakultet kemijskog inženjerstva i tehnologije, udžbenik, 2017. | NO | |
| | EU legal acts and national regulations | NO | Website EUR-Lex and Narodne novine: https://eur-lex.europa.eu/legal-content/HR/TXT/? www.nn.hr |
| 2.12. Optional literature | Herceg, N.: Okoliš i održivi razvoj, udžbenik, Synopsis, 2013. | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Professional project | 1.8. Number of hours in semester (L+E+F+e-learning) | 0+0+120 |
| 1.3. Course code | 235715 | 1.9. Expected enrolment in the course | 20 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | The goal of a professional project is to apply the acquired knowledge and practical skills in creating a project based on a given product, technology or material, in chronological order as in a real environment, with an innovative approach applied to larger projects | | |

| | |
|---|---|
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A2: Independently gather data, statistically process, present and analyse gathered data, discuss and make conclusions based on analysed data and distinguish the possibilities of different, interpretation of the same problem analysed in different ways,<br>B1: Apply current technical regulations in planning and managing systems, managing production and managing and assuring quality of wood, wooden materials and final products<br>B2: Apply scientific insights on wood as a renewable material and optimise wood usage through the application of techniques and technologies for reuse of wood excess<br>B3: Manage procedures and processes of improving natural wood disadvantages using chemical, physical and enzymatic modifications,<br>B4: Plan and analyse material handling, solve problems of transport, storage and selection of transport technique, analyse factors influencing the efficiency and expenses of wood and wooden, materials transport and storage.<br>C1: Apply technological processes of mechanical and thermo-chemical wood refinement in the manufacturing of wood fibres and paper,<br>C2: Manage wood technology processes in the field of sawmilling, hydrothermal treatment of wood, wood protection, technology of veneer and wooden board manufacturing, technology of products for building purposes, furniture and other wood products, and guide processes of wood and wooden products finishing,<br>C3: Design technologies for primary and final wood treatment, develop, improve and optimise production, and apply knowledge from the field of technique and management in the wood industry,<br>C4: Measure and evaluate quality parameters of wooden products (for building purposes) and interpret their size and meaning,<br>C5 :Choose and apply the CNC technique in final wood treatment,<br>C6: Enhance existing technologies as well as implement new technologies in the wood industry,<br>C7: Manage the industrial environment of wood processing and the wooden, chemically protected wood waste and excess.<br>D1: Recommend resource usage through the management of a process which consists of planning, organising, directing and controlling,<br>D2: Perform tasks in the field of industrial management in wood refinement and furniture manufacturing, micro planning, assignment distribution, optimisation of manufacturing decisions, production management and work control,<br>D3: Organise and manage tasks of wood materials trade and transfer,<br>D4: Manage and perform tasks in wood industry entrepreneurship,<br>E3: Gather, process and interpret reference sources and prepare simpler professional or scientific papers,<br>E5: Perform activities and tasks in publicist writing and the media related to the wood profession. |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Interdisciplinary solve a given problem in defined conditions<br>2. Solve design-technical-technological larger problems independently or as a team by applying multicriteria decision-making (choose the optimal shape, wood and non-wood materials, construction, technological process) and propose variants of rationalization-innovation of products or processes<br>3. Develop self-awareness and self-criticism and motivation in the form of assessing their abilities and weaknesses in the team<br>4. Test your own abilities for an analytical or holistic approach to work and develop a sense of constructive criticism of colleagues and superiors and a sense of personal and collective responsibility for the execution of assigned tasks in compliance with deadlines |

| | |
|---|---|
| | 5. Make a technological map with a sequence of operations according to the given technology and specifics of wood products<br>6. Define critical points in the wood technology process, suggest improvements and speed-up of the process<br>7. Apply digital technologies in production processes |
| 2.5. Course content (syllabus) | Project teaching integrates knowledge and skills from several courses related to the project task. A group of students, mentored by the gathered teachers, proposes a project solution to improve a production process or business. According to the specific needs of the professional project, the project team will perform tasks in the faculty premises, laboratories, computer classroom or workshop, or outside the Faculty, in manufacturing companies, visiting thematic exhibitions and professional fairs. |

| | | | 2.7. Comments: |
|---|---|---|---|
| 2.6. Format of instruction | ☐ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ *online in entirety*<br>☐ partial e-learning<br>☐ field work | ☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☒ work with mentor<br>☐ (other) | |

| 2.8. Monitoring student work | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Class attendance | | | Research | YES | | Oral exam | | |
| | Experimental work | YES | | Report | | | Work with mentor | YES | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | | | Practical work | YES | | (other) | | |
| | Project | YES | | Written exam | | | ECTS credits (total) | 4 | |

| | | | |
|---|---|---|---|
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | |
| 2.10. Student responsibilities | | | |
| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
| | | | |
| | | | |
| 2.12. Optional literature | | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | | 1.7. Number of ECTS credits | 14 |
| 1.2. Course title | Diploma work | 1.8. Number of hours in semester (L+E+F+e-learning) | |
| 1.3. Course code | 235716 | 1.9. Expected enrolment in the course | 25 |

| | | | |
|---|---|---|---|
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Compulsory | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |

## 2. COURSE DESCRIPTION

| | |
|---|---|
| 2.1. Course objectives | Master thesis is an independent, comprehensive and highly independent task in which the student must demonstrate knowledge of the background of the profession and of the scientific research work, ie, in the definition of hypotheses and research goals, research planning, data collection and processing and writing of scientific work. Includes expansion and deepening of knowledge of the content of the curriculum, individual engagement around the problem topics, gaining experience in writing technical papers, the ability to apply scientific methods and instruments in processing problems and drafting work, the ability of independent service corresponding domestic and foreign literature and the use of knowledge, facts and attitudes published in the mentioned sources. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. apply the current knowledge to define a scientific and professional problem in choosing the topic of work<br>2. create a schedule of work in accordance with the deadlines of making the graduate thesis in stages<br>3. independently devise a methodology of research work<br>4. apply the methodology of writing a professional and scientific work<br>5. present their work in written and oral form, using skills succinct interpretation of the results and conclusion of these guidelines to predict the future development of the topics of work |
| 2.5. Course content (syllabus) | Master thesis is an individual written work based on students' own research that is written in a scientific form and implies students' engagement in work that is equivalent to 15 ECTS module. Graduation is usually done during IV. semester on graduate study and ends with oral defense (presentation and answering the questions). |

| 2.6. Format of instruction | | | 2.7. Comments: |
|---|---|---|---|
| | ☐ lectures<br>☐ seminars and workshops<br>☐ exercises<br>☐ *online in entirety*<br>☐ partial e-learning<br>☒ field work | ☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☒ work with mentor<br>☒ public presentation of diploma work | |

| 2.8. Monitoring student work | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Class attendance | | | Research | YES | | Oral exam | | |
| | Experimental work | YES | | Report | | | Public presentation of diploma work | YES | |
| | Essay | | | Seminar paper | | | (other) | | |
| | Preliminary exam | | | Practical work | YES | | (other) | | |
| | Project | YES | | Written | | | ECTS credits | 14 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | exam | | | (total) | | | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | | |
| 2.10. Student responsibilities | Apply for the topic of the thesis, conduct research and prepare the paper in accordance with the Instructions for the design of the thesis. Come to the consultations and present the progress in conducting research and drafting the paper. Respect and follow the instructions of the mentor. Adhere to the principles of ethical approach in writing the thesis. Prepare a presentation and defend the thesis before the appointed committee. | | | | | | | | | |
| 2.11. Required literature (available in the library and/or via other media) | Title | | | Availability in the library | | | Availability via other media | | | |
| | Pravilnik o izradi i obrani diplomskog rada na diplomskim sveučilišnim studijima Šumarskog fakulteta | | | | | | http://www.sumfak.unizg.hr/StudijPojedinacno.aspx?mhID=2&mvID=43 | | | |
| | Obrazac DS-1 Zamolba za odobrenje teme i mentora diplomskog rada | | | | | | http://www.sumfak.unizg.hr/StudijPojedinacno.aspx?mhID=2&mvID=43 | | | |
| | Upute o izgledu i sadržaju diplomskog rad | | | | | | http://www.sumfak.unizg.hr/StudijPojedinacno.aspx?mhID=2&mvID=43 | | | |
| 2.12. Optional literature | | | | | | | | | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assoc. Prof. Alan Antonović, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Biorafinerijske tehnologije drva | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15(S)+0 |
| 1.3. Course code | 235731 | 1.9. Expected enrolment in the course | 10 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Acquiring knowledge of various biorefinery technologies based on the chemical properties and characteristics of lignocellulosic biomass. Identify and explain different sources of lignocellulosic biomass suitable for biorefinery technologies in the production of various bioproducts. Describe and explain the processes of lignocellulosic biomass conversion into different platforms / building blocks as mediators in bioproduct production. Learn, define and describe the appearance of a biorefinery plant and analyze the technical and technological parameters of technology in the production of various bioproducts. Learn to classify, differentiate, define and apply different bioproducts obtained with the help of biorefinery technologies. | | |

| | |
|---|---|
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A1: Explain the position and trends of the wood industry in the country and worldwide,<br>B2: Apply scientific insights on wood as a renewable material and optimise wood usage through the application of techniques and technologies for reuse of wood excess,<br>B3: Manage procedures and processes of improving natural wood disadvantages using chemical, physical and enzymatic modifications,<br>C1: Apply technological processes of mechanical and thermo-chemical wood refinement in the manufacturing of wood fibres and paper,<br>C6: Enhance existing technologies as well as implement new technologies in the wood industry, |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. identify and explain different sources of lignocellulosic biomass suitable for biorefinery technologies in the production of various bioproducts,<br>2. critically evaluate different biorefinery technologies for the production of different bioproducts (bioenergy, biofuels, biogas and biochemicals) from lignocellulosic biomass and analyze potential future price reductions through technological development,<br>3. explain and present the basic technical-technological concepts of various biorefinery technologies and their practical applications related to engineering systems for the production of organic products,<br>4. identify and describe bio-products with higher added value obtained by biorefinery technologies from lignocellulosic biomass,<br>5. draw and construct simple schemes of biorefinery technologies and critically assess the potential of biorefinery processes |
| 2.5. Course content (syllabus) | LECTURES:<br>1. Bioeconomy and circular economy; Introduction to biorefinery technologies; Environmental, logistical, energy, economic and socio-social aspects of biorefinery technologies; Mapping biorefinery technologies in the World;<br>2. Wood as a raw material for the production of organic products, characterization and evaluation; Reactions of wood chemical compounds; Introduction to protocols and research techniques of wood chemical composition,<br>3. Processes of wood conversion into biorefinery platforms; Mechanical and physical processes - pressing, grinding, separation, fiber separation, fractionation, extraction, upgrading; Biochemical processes - anaerobic digestion, aerobic / anaerobic fermentation, enzymatic conversion, transesterification; Chemical processes - hydrolysis, oxidation, branching; Thermochemical processes - combustion, gasification, pyrolysis, hydrothermal upgrading, torefication, liquefaction, hydrogenation;<br>4. Wood pretreatments 1; Pre-treatments of cellulose polysaccharides and wood polyoses / hemicelluloses (hydrolysis, fermentation, chemical treatments); Introduction to chemical and biotechnological methods used for pretreatment and enzymatic hydrolysis of wood; Fermentation of sugars into chemicals to produce bioethanol;<br>5. Wood pretreatments 2; Lignin pretreatments (radical and chemical pretreatments) in the process of obtaining phenolic bioproducts; Lignin regeneration processes; Valorization of lignin and its derivatives into organic products;<br>6. Introduction to biorefinery bioproducts; Bioenergy; Biofuels; Biogas; Biomaterials - biopolymers and biochemicals;<br>7. Biorefinery technologies; Classification of biorefinery technologies; Introduction to different types and concepts of biorefinery technologies; Operating flow and material flow;<br>8. Biorefinery technologies for bioenergy and biofuel production 1; Liquid wood fuels; Enzymatic conversion of wood for the production of various organic products; Basic concepts of enzymatic biocatalysis for the conversion of wood into biofuels and biochemicals; Enzyme classification; Bioethanol; Bio-ETBE; Biodiesel; Bioethers MTBE and TAME; Cellulose ethanol; Advanced biodiesel; BTL; BIO-SNG; HEFA; BioDME; Biohydrogen; Biobutanol; Biomethanol; Bio oils; Ground oil;<br>9. Biorefinery technologies for the production of bioenergy and biofuels 2; Biochar, biogas and biooils; Chemical processes (catalytic and thermochemical processes) for the conversion |

<table>
<tr><td></td><td colspan="9">of wood into biofuels and biochemicals; Biotechnologies for the production of biochemicals and biofuels from extractives of wood (use of triacylglycerols, fatty acids and glycerols); Fermentation of sugar into chemicals for biodiesel production;<br>10. Biorefinery technologies for biogas production; Anaerobic digestion; Degradation mechanisms; Bioreactors and process parameters; Biogas purification; Biogas valorization; Environmental regulation and biogas safety;<br>11. Biorefinery technologies for biomaterial production 1; Building blocks and biochemicals; Methane; Carbon monoxide; Methanol; Monoethylene glycol; Milk acid; Succinic acid; Ethyl lactate; Propylene glycol; 1,3-Propanediol (PDO); Epilochidrin; Propylene; Acrylic acid; Acrylonitrile; Acrylamide; Butanol; Adipic acid; Isoprene;<br>12. Biorefinery technologies for biomaterial production 2; Building blocks and biochemicals; Furani; Farnes; Teraphthalic acid; 3-hydroxypropionic acid; Aspartic acid; Glutamic acid; Levulinic acid; Polyhydroxyalkanoates;<br>13. Biorefinery technologies for biopolymer production 1; Bio-polyethylene (Bio-PE); Bio-polypropylene (Bio-PP); Bio-polyethylene phthalate (Bio-PET); Bio-polytrimethylene terephthalate (Bio-PTT);<br>14. Biorefinery technologies for biopolymer production 2; Thermoplastic copolyester elastomer (TCP); Polylactic acid (PLA); Polyhydroxyalkanoates (PHA); Polybutylene adipate-co-terephthalate (PBAT);<br>15. Biorefinery technologies for biopolymer production; Lignocellulosic biomass liquefaction mechanisms; Liquefaction with phenols; Liquefaction with polyhydric alcohols; Application of liquefied lignocellulosic biomass in biopolymers; Bioformaldehyde polymers;<br><br>PRACTICAL WORK:<br>1. Preparation of wood samples for chemical analysis,<br>2. Determination of the elemental composition of wood by flame atomic absorption spectrometry (FAAS) and CHNSO analysis,<br>3. Determining the group chemical composition of wood in order to determine the parameters of biorefinery analyzes,<br>4. Identification and characterization of group chemical composition of wood with instrumental hibernetic assembly,<br>5. Determination of the content and ratio of enzymes for dissolving wood polysaccharides,<br>6. Fermentation of wood polysaccharides in the production of bioethanol,<br>7. Determination of biochar, biogas and bio-oil content by pyrolytic decomposition of wood,<br>8. Determination of OH-number of liquefied wood,<br>9. Determination of the degree of liquefaction and solids content and dry matter content of wood,<br>10. Obtaining polylactic acid from wood hemicellulose and determining its properties and characteristics,<br>11. Obtaining succinic acid from wood hemicellulose and determining its properties and characteristics,<br>12. Synthesis of formaldehyde resins with liquefied wood and determination of properties of obtained bioproducts.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☐ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td rowspan="5">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td>YES</td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td>YES</td><td></td><td>Report</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary</td><td>YES</td><td></td><td>Practical</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
</table>

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | exam | | | work | | | | | |
| | Project | YES | | Written exam | YES | | ECTS credits (total) | 4 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | | | | | | | | | |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | A. Antonović (2018): Kemija drva (interna skripta). Šumarski fakultet, Zagreb | NE | DA |
| | N. Quereshi, D. Hodge, A.A. Vertes (2014): Biorefineries: Integrated biochemical processes for liquid biofuels. Elsevier, | NE | DA |
| | C.A.C. Alzate, J.M. Botero, V.A. Marulanda (2018): Biorefineries – Design and Analysis. CRC Press, | NE | DA |
| | J.-L. Wertz, O. Bedue (2013): Lignocellulosic birefineries. EPFL Press, | NE | DA |
| | M. Rabacal, A.F. Ferreira, C.A.M. Silva, M. Costa (2017): Biorefineries – Targeting energy, high value products and waste valorisation. Springer International Publishing, | NE | DA |
| | J.-L. Wertz, M. Deleu, S. Coppee, A. Richel (2019): Hemicellulose nad lignin in biorefineries. CRC Press, | NE | DA |
| 2.12. Optional literature | K. Wageman, N. Tippkotter (2019): Biorefineries. Springer Interantional Publishing | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assist. Prof. Miljenko Klarić, PhD.<br>Prof. Mladen Brezović, PhD<br>Assist. Prof. Nikola Španić, PhD<br>Prof. Vladimir Jambreković, PhD<br>Prof. Stjepan Pervan, PhD<br>Assoc. Prof. Josip Ištvanić, PhD<br>Assoc. Prof. Alan Antonović, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Design of wood materials production process | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15(S)+0 |
| 1.3. Course code | 235732 | 1.9. Expected enrolment in the course | 10 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |

| | | | |
|---|---|---|---|
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | The aim of the course is to train experts for daily work on the development and design of wood production processes, within the materials technology, with the constant improvement of the existing process or the formation of a new production process. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | Entry competencies in the form of general knowledge from: wood chemistry, sawmilling, wood drying, technology of chipped wood, veneer and plywood, and composite plywood. | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A3: apply simpler methods of operational research<br>B2: apply scientific knowledge about wood as a renewable material and optimize the use of wood by applying techniques and technologies for the recovery of wood residues<br>B3: manage procedures and processes for improving natural wood deficiencies by chemical, physical and enzymatic modifications<br>B4: design and analyze material handling, solve problems of transport, storage and choice of transport technology, analyze influencing factors on the efficiency and costs of transport and storage of wood and wood materials<br>C1: apply technological procedures of mechanical and thermo-chemical processing of wood in the production of wood fibers and paper<br>C2: manage wood technological processes in the field of sawmilling, hydrothermal wood processing, wood protection, technology of veneer and wood panels production, technology of construction products, furniture and other wood products, and manage the processes of surface treatment of wood and wood products<br>C3: design primary and final wood processing technologies, develop, improve and optimize production and apply knowledge in the field of engineering and management in the wood industry<br>C6: improve existing technologies as well as introduce new technologies in the wood industry<br>D5: run the most complex businesses in all forms of woodworking, processing and trade companies and consulting and design companies | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Know and evaluate conventional materials technologies in the wood processing industry.<br>2. Distinguish the processes of production and design of wood materials.<br>3. Detect, analyze and distinguish between present and possible problems in wood production processes.<br>4. Prepare and propose the wood production process.<br>5. Valorize and standardize and integrate the developed process of wood production. | | |
| 2.5. Course content (syllabus) | 1. Chemical processing of wood and application of wood chemistry in wood production processes<br>2. Flow analysis and detection of problems in wood processing processes in sawmills and finishing plants<br>3. Development of thermo-hydro-mechanical processes, combining with problem detection<br>4. Traceability of individual phases and development of the process of production of chipboard and fibreboards,<br>5. Evaluation and detection of problems of certain technological processes of production of wood-plastic composites<br>6. Nanotechnology in the processes of production of wood composites and paper<br>7. Development of veneer and plywood production process<br>8. Composite laminated wood and composite applicable materials<br>9. Combining and integrating different materials in order to obtain higher value products, the basis for process design<br>10. Evaluation of wood and composite materials technology<br>11. Connecting compatible technologies<br>12. By-products and residues of the production process, possibilities of reuse and inclusion in the production process | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 13. Technological supervision, analysis and corrections of wood production processes<br>14. Safety and health factors in the design of wood production processes<br>15. Examples of industrial design technology of wood processing processes | | | | | | | | |
| 2.6. Format of instruction | ☒ lectures<br>☒ seminars and workshops<br>☐ exercises<br>☐ *online in entirety*<br>☒ partial e-learning<br>☐ field work | | | ☒ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☒ work with mentor<br>☐ (other) | | | 2.7. Comments: | | |
| 2.8. Monitoring student work | Class attendance | YES | | Research | YES | | Oral exam | YES | |
| | Experimental work | YES | | Report | YES | | (other) | | |
| | Essay | | | Seminar paper | YES | | (other) | | |
| | Preliminary exam | YES | | Practical work | | | (other) | | |
| | Project | YES | | Written exam | YES | | ECTS credits (total) | 4 | |
| 2.9. Assessment methods and criteria | Assessment is conducted in accordance with Assessment methods and criteria for the current academic year. | | | | | | | | |
| 2.10. Student responsibilities | | | | | | | | | |

| 2.11. Required literature (available in the library and/or via other media) | Title | Availability in the library | Availability via other media |
|---|---|---|---|
| | Schenk, M., Wirth, S., Mueuller, E. 2010: Factory Planning Manual. Situation-Driven Production Facility Planning, Springer 410 p. | NE | PDF |
| | Wiendahl, H.P., Reichardt, J., Nyhuis, P. 2015: Handbook Factory Planning and Design. Springer 501 p. | NE | PDF |
| | *** 2022: Factory Design Utilities. Autodesk. | NE | ONLINE |
| | *** 2010: Wood Handbook - Wood as an engineering material. FPL, Madison, Wisconsin. | NE | PDF |
| | Brezović, M. 2020: Tehnologija furnira i uslojenog drva. Interna skripta. | NE | PDF |
| | Kasal, B., Friebel, S., Gunschera, J., Salthammer, T., Schrip, A., Schwab, H., Thole, V. 2015: Wood-Based Materials. In: Ullmann's Encyclopedia of Industrial Chemistry. Wiley-VCH Verlag GmbH & Co. | NE | PDF |
| 2.12. Optional literature | *** 2021: The smart factory Responsive, adaptive, connected manufacturing. A Deloitte series on Industry 4.0, digital manufacturing enterprises, and digital supply networks. Deloitte University press.<br>Kalia, S., Kaith, B.S., Kaur, I. (eds.) 2011: Cellulose Fibers: Bio- and Nano-Polymer Composites. Springer-verlag Berlin Heidelberg. | | |

COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assist. Prof. Branimir Šafran PhD<br>Marko Rastija, mag. ing. mech. | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Biomass and solid wood biofuels production | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+0 |
| 1.3. Course code | 235733 | 1.9. Expected enrolment in the course | 10 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |

| 2. COURSE DESCRIPTION | |
|---|---|
| 2.1. Course objectives | Analyze technological processes of solid biofuel production. Overcome the basic principles and mechanisms of binding of biomass particles to compact solid biofuel. Analyze and use scientific methods to identify shortcomings and propose technological and scientific solutions to improve the production of solid biofuels. |
| 2.2. Enrolment requirements and/or entry competences required for the course | - |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A1 - Explain the position and trends of the wood industry in the country and worldwide,<br>A2 - Independently gather data, statistically process, present and analyses gathered data, discuss and make conclusions based on analysed data and distinguish the possibilities of different, interpretation of the same problem analysed in different ways<br>B1 - Apply current technical regulations in planning and managing systems, managing production and managing and assuring quality of wood, wooden materials and final products<br>C6 - Enhance existing technologies as well as implement new technologies in the wood industry |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Comprehend the basic principles of binding wood raw material into compact solid biofuel and to analyze the impact of certain production parameters on product quality and energy consumption in order to increase productivity and reduce energy consumption.<br>2. Apply the acquired knowledge in the production of solid biofuels and lead the production process.<br>3. Design a system for combustion of solid biofuels (selection of the boiler, calculation of the required amount of material and size of the tank and fuel feeding system in the furnace).<br>4. Conduct research on selected raw materials and with technological solutions increase system productivity and biofuel quality (influence of raw material, particle size, moisture, additives, pressing temperature and pressure, cooling to quality and productivity). |
| 2.5. Course content (syllabus) | 1. L - Biomass sources - forest biomass, agricultural biomass, fast growing biomass (SRC), aquatic biomass<br>2. L + E - Establish fast-growing crops (SRC), energy analysis of SRC in relation to agricultural and forest biomass<br>3. L + E - Conversion factors for different types of biomass (biofuels) and humidity conditions<br>4. L - Technological process of briquette and pellet production; Production stages: transport, unloading, crushing, metal separation, drying, conditioning, pelleting, screening, cooling, packaging, storage<br>5. L - Influence of production parameters on pellet quality (drying, humidification, additives, temperature and pressure, chemical composition of biomass, particle size, cooling)<br>6. L + E – Raw material selection, preparation and grinding of samples for laboratory pellet production<br>7. L + E - Mixing and conditioning of samples, granulometric analysis of raw materials |

<table>
<tr><td></td><td colspan="9">8. L + E- Chemical analysis of raw materials for pellet production; Additives in pellet production<br>9. L + E - Laboratory production and analysis of pellet production process according to experiential data and scientific knowledge<br>10. L+E - Laboratory pressing of pellets according to predefined parameters and scientific knowledge<br>11. L + E - Analysis of properties of laboratory-produced pellets (density, mechanical properties, resistance to external influence)<br>12. L + E - Determination of dimensions, mass, mechanical properties and resistance to external influence of produced pellets<br>13. L- Modeling of pellet production process - defining densifying pressure and compression ratio<br>E - Analysis of laboratory production of pellets and development of models and parameters for industrial production<br>14. L- Combustion systems of solid biofuels; Boilers, boiler plants and cogeneration<br>15. L + E- Design of solid biofuel combustion system (boiler selection, calculation of required quantity and tank size, system for automatic fuel dosing into the combustion chamber), efficiency of boiler / system</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td>YES</td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td></td><td>Report</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td></td><td></td><td>Practical work</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td>Written exam</td><td>YES</td><td></td><td>ECTS credits (total)</td><td>4</td><td></td></tr>
<tr><td></td><td colspan="9"></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9"></td></tr>
<tr><td rowspan="5">2.11. Required literature (available in the library and/or via other media)</td><td colspan="5">Title</td><td colspan="2">Availability in the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td colspan="5">Obernberger, I., & Thek, G. (2010). The Pellet Handbook – the production and thermal utilisation of biomass pellets. (1 ed.) London, UK: Earthscan Ltd.</td><td colspan="2">-</td><td colspan="2">da</td></tr>
<tr><td colspan="5">Risović, S. 2003: Briketi i pelete – novi energent na hrvatskome tržištu; 123-141 - Risović, S.; Figurić, M. 2003: Šumska biomasa, 2003.</td><td colspan="2">da</td><td colspan="2">-</td></tr>
<tr><td colspan="5">Stelte, W. 2011: Fuel Pellets from Biomass - Processing, Bonding, Raw Materials, Risø-PhD-90 (EN), 1–47</td><td colspan="2">-</td><td colspan="2">da</td></tr>
<tr><td colspan="5">Labudović, B. 2012: Osnove primjene biomase, Energetika marketing Zagreb</td><td colspan="2">-</td><td colspan="2">da</td></tr>
</table>

| | | | |
|---|---|---|---|
| | Radovi raznih autora | - | da |
| | Interni materijali | - | da |
| 2.12. Optional literature | | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Prof. Ružica Beljo Lučić, PhD<br>Assoc. Prof. Igor Đukić, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Wood machining optimization | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+0 |
| 1.3. Course code | 235734 | 1.9. Expected enrolment in the course | 15 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | The aim of the course is to enable students to critically analyze the processes in wood machining and to research the influence of machining parameters on machine capacity, machined surface roughness, tool life expectancy, energy consumption, energy efficiency and also the emissions of noise, vibration and wood dust. Students should acquire knowledge and skills for the calculation and selection of optimal machining parameters in order to achieve maximum performance with satisfactory machined surface roughness, maximum effective tool time between two sharpenings with constraints set by the tool, main motor power, sawdust extraction system parameters and permissible noise emission and vibration limits. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | Passed exam in course Quantative methods for operational research. | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | A2 - Independently gather data, statistically process, present and analyses gathered data, discuss and make conclusions based on analysed data and distinguish the possibilities of different, interpretation of the same problem analysed in different ways<br>C3 - design primary and final wood processing technologies, develop, improve and optimize production and apply knowledge in the field of engineering and management in the wood industry<br>E3 - collect, process and interpret sources of literature and prepare simpler written professional or scientific work | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | Students will be able to:<br>1. investigate and explain the relationships between the most influental factors in wood machining<br>2. recognize, analyze and apply economic, energy, ergonomic and environmental requirements in modern wood machining<br>3. calculate the maximum feed speed obtainable with the given parameters of the workpiece material, tools and machine, with a constrain related to the required machined surface quality<br>4. calculate the required amount of air for extraction of wood chips in a unit of time depending on the wood machining parameters and the type of machine | | |

<table>
<tr><td></td><td colspan="9">5. state the goals of wood machining process, define the function to be optimized and determine the parameters that limit the space of possible solutions of the function<br>6. apply simpler optimization methods for choosing optimal wood machining parameters</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td colspan="9">Defining the wood machining process parameters: performance, cutting power, energy consumption, specific cutting energy, machining accuracy, machined surface quality, tool wear, tool blade heating, noise and dust emissions, vibration and properties of chips obtained from machining.<br>Economic, energy, ergonomic and ecological requirements in the modern technological process of wood machining.<br>Analysis of the influence of different machining parameters (machine types, rotational frequency, cutting speed, feed speed, main motor power) on the output values of the machining process.<br>Analysis and influence of tool parameters (different materials and tool design, geometry, vibration damping system).<br>Analysis of the influence of workpiece parameters (types of wood and wood materials, structural, physical and mechanical properties, cutting directions, moisture content, workpiece dimensions, machining allowance) on the output values of the machining process.<br>Analysis of human influence (knowledge, skills, psychophysical condition) on the output values of the machining process.<br>Analysis and determination of dimensions and shapes of wood chips that occur during a certain wood machining process and design of the required amount of air flow for suction of wood particles.<br>Defining machining objectives, optimality criterion functions, and constraining factors: possible constraints imposed by machine, tool, workpiece and human operator.<br>Possibilities of application of optimization methods for determination of optimal parameters in wood machining with regard to processing requirements and limitations.<br>Methods for solving the optimization problems in wood machining using computers.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☐ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☒ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
<tr><td rowspan="6">2.8. Monitoring student work</td><td>Class attendance</td><td>YES</td><td></td><td>Research</td><td>YES</td><td></td><td>Oral exam</td><td>YES</td><td></td></tr>
<tr><td>Experimental work</td><td>YES</td><td></td><td>Report</td><td></td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td>Seminar paper</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Preliminary exam</td><td></td><td></td><td>Practical work</td><td>YES</td><td></td><td>(other)</td><td></td><td></td></tr>
<tr><td>Project</td><td>YES</td><td></td><td>Written exam</td><td></td><td></td><td>ECTS credits (total)</td><td>4</td><td></td></tr>
<tr><td></td><td colspan="9"></td></tr>
<tr><td>2.9. Assessment methods and criteria</td><td colspan="9">Assessment is conducted in accordance with Assessment methods and criteria for the current academic year.</td></tr>
<tr><td>2.10. Student responsibilities</td><td colspan="9"></td></tr>
<tr><td rowspan="2">2.11. Required literature (available in the library and/or via other media)</td><td colspan="4">Title</td><td colspan="2">Availability in the library</td><td colspan="3">Availability via other media</td></tr>
<tr><td colspan="4">Goglia, V., 1994: Strojevi i alati za obradu drva: 1. dio. Šumarski fakultet Sveučilišta u Zagrebu, Zagreb.</td><td colspan="2">da</td><td colspan="3">ne</td></tr>
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|---|---|---|---|
| | Csanády, E., Magoss, E., 2011: Mechanics of Wood Machining. Department of Wood Engineering, University of West Hungary, Sopron. | da | ne |
| | Šavar, Š., 1990: Obrada metala odvajanjem čestica. Školska knjiga Zagreb. | da | ne |
| 2.12. Optional literature | Gottlöber, C., 2014: Zerspanung von Holz und Holzwerkstoffen. Fachbuchverlag Leipzig, Carl Hanser Verlag.<br>Parkinson, R., Balling, R. J., Hedengren, J. D., 2013: Optimization Methods for Engineering Design – Applications and Theory. Brigham Young University.<br>Martins, J. R. R. A., Ning, A., 2020: Engineering Design Optimization. | | |

## COURSE DECRIPTION

| 1. GENERAL INFORMATION | | | |
|---|---|---|---|
| 1.1. Course lecturer(s) | Assoc. Prof. Vjekoslav Živković, PhD | 1.7. Number of ECTS credits | 4 |
| 1.2. Course title | Quality of wood building products | 1.8. Number of hours in semester (L+E+F+e-learning) | 30+15+0 |
| 1.3. Course code | 235735 | 1.9. Expected enrolment in the course | 10 |
| 1.4. Study programme | Graduate | 1.10. Level of application of e-learning (level 1, 2, 3) | 2. |
| 1.5. Course type | Elective | 1.11. Language of instruction | Croatian |
| 1.6. Year of the study | 2. | 1.12. Possibility of instruction in English | Yes |
| 2. COURSE DESCRIPTION | | | |
| 2.1. Course objectives | Introduction to the specifics of quality assurance of wood building products (floor coverings, doors and windows, load-bearing elements), technical regulations, minimum requirements, evaluation of test results, establishing factory production control, product safety and quality labels, accreditation, notification, testing, product and production certification in ensuring the safety and quality of wood building products. | | |
| 2.2. Enrolment requirements and/or entry competences required for the course | - | | |
| 2.3. Learning outcomes at the level of the programme to which the course contributes | B1 - Apply current technical regulations in planning and managing systems, managing production and managing and assuring quality of wood, wooden materials and final products,<br>C4 - Measure and evaluate quality parameters of wooden products (for building purposes) and interpret their size and meaning. | | |
| 2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes) | 1. Connect the product with the appropriate regulation and standard and propose the appropriate system of factory production control<br>2. Identify the specifics of the product and determine the methods of testing or evaluating the properties of wood products for construction<br>3. Define activities essential for obtaining a certain quality or safety mark (eg CE mark)<br>4. Define spatial, technical and environmental conditions, documentation and requirements for staff in the system of own factory control<br>5. Interpret the test report and evaluate the achieved results<br>6. Propose measures to eliminate non-conformities of wood building products | | |
| 2.5. Course content (syllabus) | Significance and importance of safety and quality of wood building products from the aspect of user safety, environmental protection and energy efficiency. Regulations for wood | | |

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<tr><td></td><td colspan="9">building products. Meaning and content of product safety and quality labels. Standards in the regulated area and voluntary standards. The role of accreditation and notofocation of the laboratory - review of quality systems and technical requirements according to the standard for the organization and accreditation of laboratories. Factory production control - significance, scope, methods and procedures, equipment, check points, personnel, environmental conditions, supervision. Evaluation of the results of the control of the properties of floor coverings, doors and windows, solid and layered construction wood and surface treatment of products. Influence of material quality, production process, conditions of installation and maintenance of products on quality in the anticipated service life.</td></tr>
<tr><td>2.6. Format of instruction</td><td colspan="3">☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☐ online in entirety<br>☒ partial e-learning<br>☒ field work</td><td colspan="3">☒ independent assignments<br>☐ multimedia and the internet<br>☐ laboratory<br>☐ work with mentor<br>☐ (other)</td><td colspan="3">2.7. Comments:</td></tr>
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<tr><td colspan="5">Domljan, D.; Grbac, I.; Jirouš Rajković, V.; Vlaović, Z.; Živković, V.; Župčić, I. 2015: Kvaliteta i tehnički opisi proizvoda od drva, Svezak I opremanje zgrada za odgoj i obrazovanje, sveučilišni priručnik Sveučilište u Zagrebu Šumarski fakultet, Zagreb.</td><td colspan="2">YES</td><td colspan="2"></td></tr>
<tr><td colspan="5">Turkulin, H. 2015: Svojstva i primjena drvenih podova, LDG stručna biblioteka, Sveučilište u Zagrebu Šumarski fakultet, Zagreb</td><td colspan="2">YES</td><td colspan="2"></td></tr>
<tr><td colspan="5">Turkulin, H. 2019: Posebnosti izvedbe drvenih podova, LDG stručna biblioteka, Sveučilište u Zagrebu Šumarski fakultet, Zagreb</td><td colspan="2">YES</td><td colspan="2"></td></tr>
<tr><td colspan="5">Zbirka propisa o građevnim proizvodima od drva</td><td colspan="2"></td><td colspan="2">YES</td></tr>
<tr><td colspan="5">Živković, Vjekoslav ; Miklečić, Josip (ur.) (2015) Enhancing EU-competitiveness of Croatian Wood Flooring Industry / zbornik radova. Zagreb: Šumarski fakultet, 2015. str. 1-71</td><td colspan="2">YES</td><td colspan="2"></td></tr>
<tr><td colspan="9"></td></tr>
<tr><td>2.12. Optional literature</td><td colspan="9"></td></tr>
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