

# WOOD SCIENCE AND ENGINEERING

Use of renewable materials is increasing as the world becomes more concerned about climate change and population growth. Americans use thousands of different products such as wood each year—by weight more than we do of steel, cement and plastic combined. To meet the growing demand for renewable materials and to maximize the benefits of bio-energy and renewable products we must be smarter in how and where we use them. New opportunities for the world through renewable materials is the core of wood science and engineering at OSU.

The department is a world leader in research, outreach and education related to renewable, wood-based materials and products. It offers an undergraduate degree program in Renewable Materials that prepares students for diverse careers in the private sector that is a major component of the Pacific Northwest economy and around the world. Graduates are in high demand as climate change concerns and advanced technology accelerate the transformation to a globally competitive, green renewable materials-based industry.

The department also offers MS and PhD degrees in Wood Science. These graduate programs ensure a foundation in science that is supplemented with programs tailored to student interest. Many students pursue dual majors in science or engineering fields. Interested students should see the department Web page for more information or contact the department head.

## Undergraduate Programs

### Major

- Renewable Materials (<http://catalog.oregonstate.edu/college-departments/forestry/wood-science-engineering/renewable-materials-bs-hbs>)

#### Options

- Advanced Wood Manufacturing*
- Art and Design*
- Science and Engineering*
- Management and Marketing*

### Minor

- Renewable Materials (<http://catalog.oregonstate.edu/college-departments/forestry/wood-science-engineering/renewable-materials-minor>)

## Graduate Programs

### Major

- Wood Science (MAIS, MS, PhD) (<http://catalog.oregonstate.edu/college-departments/forestry/wood-science-engineering/wood-science-ms-phd-mais>)

### Minor

- Wood Science (<http://catalog.oregonstate.edu/college-departments/forestry/wood-science-engineering/wood-science-graduate-minor>)

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## Faculty

**Professors** Gupta, Hansen, Kamke, Nairn, Muszynski, Schimleck, Simonsen

**Associate Professors** Knowles, Leavengood, Sinha

**Assistant Professors** Robinson, Riggio

**Instructors** Fore, Hermann, G. Li, Mangla

## Affiliate Faculty

Aimene, Bull, Kozak, Kutnar, Tokarczyk, Toppinen, Zelinka

## Adjunct Faculty

A. Barbosa (Civil and Construction Engineering), T. Miller (Civil and Construction Engineering)<sup>1</sup>

<sup>1</sup> Licensed Professional Engineer

## Wood Science and Engineering

### WSE 111. RENEWABLE MATERIALS FOR A GREEN PLANET. (2 Credits)

Renewable materials are an integral part of modern lifestyles, and current societal trends point to increased use of renewable materials. This course provides an overview of renewable materials and their current applications in society. As an overview course, it covers a breadth of renewable material uses and exposes students to life-cycle thinking.

### WSE 210. \*RENEWABLE MATERIALS TECHNOLOGY AND UTILIZATION. (4 Credits)

Characteristics and uses of renewable fiber products including wood, bamboo and grasses; manufacturing processes; effect of tree growth and harvesting on renewable products manufacturing and properties. Wood identification. Lec/lab. (Bacc Core Course)

**Attributes:** CPPS – Core, Pers, Physical Science

### WSE 211. WOODTURNING WITH SCIENCE I. (4 Credits)

An introduction to scientific woodturning. Students will get a grounding in tools, lathes, sharpening, and set-up, and then will transition into turning basic forms (spindle and bowl). Particular relevance will be placed upon grain orientation, wood moisture content, wood anatomy, wood chemistry, wood species and extractive effects, and how all of these attributed affect both form and function. Class instruction will be entirely studio based. CROSSLISTED as ART 211.

**Prerequisites:** WSE 210 (may be taken concurrently) with D- or better

**Equivalent to:** ART 211

*This course is repeatable for 8 credits.*

### WSE 225. PRINCIPLES OF ARCHITECTURAL DESIGN WITH RENEWABLE MATERIALS. (3 Credits)

Introduction to architectural design, considering the different building requirements and the solutions available, with a focus on wood-based products and other ligno-cellulosic materials.

**Prerequisites:** WSE 210 with D- or better

### WSE 250. CAD: COMPUTER AIDED DESIGN. (3 Credits)

Provides students with the tools and techniques to design and render products, furniture, and structures using Solidworks, as well as create technical drawings that facilitate communication between designers, engineers, and clients. The techniques developed during this course are applicable to a wide variety of industrial CAD and product design industries worldwide. Lec/lab/studio.

**WSE 266. \*INDUSTRIAL HEMP. (3 Credits)**

Introduction to the botany, biology and agronomy of the hemp plant, and the origins, historical contexts and implications of contemporary legal and social issues surrounding its use for food, fiber, and building products. Taught via Ecampus only. (Bacc Core Course)

**Attributes:** CPSI – Core, Pers, Soc Proc & Inst; CPWC – Core, Pers, West Culture

**WSE 299. SPECIAL TOPICS. (0-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 320. ANATOMY OF RENEWABLE MATERIALS. (3 Credits)**

Examination of macroscopic and microscopic anatomy of renewable (plant based) materials commonly used by society. Learning activities including lecture and the hands-on study of the various plant materials and their components with naked-eye, hand lens, and microscopic examination. Lec/lab.

**WSE 321. CHEMISTRY OF RENEWABLE MATERIALS. (3 Credits)**

Chemical structures and chemical properties of renewable plant-based materials will be taught at molecular levels. Chemical compositions of different renewable materials will be covered. Chemical and biochemical modifications and applications or renewable materials will be discussed in detail. Lec/lab.

**Prerequisites:** CH 122 with D- or better or CH 202 with D- or better or CH 232 with D- or better or CH 232H with D- or better

**WSE 322. PHYSICAL AND MECHANICAL PROPERTIES OF RENEWABLE MATERIALS. (4 Credits)**

Introduction to thermodynamics and mechanics of plant fibers, solid wood and bio-based composites: hygroscopicity; heat and mass transport; statics, elasticity and strength of materials; mechanical properties.

**Prerequisites:** WSE 321 with C- or better

**WSE 324. RENEWABLE MATERIALS LABORATORY. (3 Credits)**

Integrates the knowledge gained in the core science courses (WSE 321 and WSE 322) to help students obtain a deeper understanding of how chemistry, physics, and anatomy affect renewable material properties. The course uses renewable fiber materials such as hardwoods, softwoods, natural fibers, bamboo, composite wood products (e.g. OSB, plywood, MDF, etc.) and fiber-based products (e.g. wood-plastic composites, natural fiber composites, straw panels, paper, etc.) to examine the intricate relationships between fundamental properties and performance. Lec/lab.

**Prerequisites:** WSE 321 with C- or better and WSE 322 [C-]

**WSE 350. SECONDARY PRODUCTS DESIGN AND MANUFACTURING. (3 Credits)**

Provides students with hands-on experience designing and manufacturing wood furniture. Includes how to safely operate and properly maintain wood working equipment, as well as how to design for consumers with efficient manufacturing processes in mind. Lec/lab/studio.

**Prerequisites:** WSE 250 with C- or better

**WSE 351. ADVANCED CAD: COMPUTER AIDED DESIGN. (3 Credits)**

Develop advanced techniques using industry standard CAD software as it relates to wood based product, furniture, and structural design. Build upon the skills acquired during WSE 250 CAD: COMPUTER AIDED DESIGN and learn advanced Solidworks techniques. Introduction to Rhinoceros 3D software and various parametric plugins. Lec/studio.

**Prerequisites:** WSE 250 with C- or better

**WSE 352. CAM FOR THE CNC ROUTER AND LASER ENGRAVER. (3 Credits)**

Process G-code using CAM software for CNC routing operations, as well as create raster and vector drawings for laser cutting/engraving applications. Each student will work through the design process researching and conceptualizing ideas, 3D modeling designs, developing working prototypes, and fabricating a final product. Lec/lab/studio.

**Prerequisites:** WSE 350 with C- or better

**Recommended:** Introductory level CAD course or demonstrated proficiency in industry standard CAD software

**WSE 385. \*EVALUATING SUSTAINABILITY THROUGH LIFE CYCLE ANALYSIS. (3 Credits)**

With increased focus on sustainability, it has become important to quantify a sustainability metric of a material, process, or a system. To that end an understanding of life cycle analysis (LCA) is needed that can be used to determine a sustainability metric. This Ecampus course presents the use of LCA to gain insights on the environmental and social impacts of the choices we make. (Bacc Core Course)

**Attributes:** CSST – Core, Synthesis, Science/Technology/Society

**WSE 392. \*BAMBOOLOOZA: THE FASCINATING WORLD OF BAMBOO. (3 Credits)**

An exploration of the world of bamboo and its application to renewable products. This course provides an in-depth understanding of a renewable material bamboo from its native form to processed products. Additionally, this course discusses the utilization and perception of bamboo in different societies of the world. Taught via Ecampus only. (Bacc Core Course)

**Attributes:** CSST – Core, Synthesis, Science/Technology/Society

**WSE 399. SPECIAL TOPICS. (0-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 401. RESEARCH. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 403. THESIS. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 405. READING AND CONFERENCE. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 406. PROJECTS. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 413. WOODTURNING WITH SCIENCE II. (4 Credits)**

An in-depth look at how character in wood (figure, spalting, knots, etc.) affects machinability and output in both functional and aesthetic turning. Students will work with a wide range of spalted wood types and figure across numerous species while working on advanced turning forms. Particular emphasis will be placed upon how figure affects grain orientation, how spalting affects density and stability, and how the challenges with character wood can be overcome without specialty tools. Class instruction will be entirely studio based. CROSSLISTED as ART 413.

**Prerequisites:** WSE 210 with C- or better and WSE 211 [C-]

**Equivalent to:** ART 413

*This course is repeatable for 8 credits.*

**WSE 414. \*ART AND DESIGN CAPSTONE. (4 Credits)**

For the final term of a student's last year in the Renewable Materials Industrial Design program, this course brings together the basic collaborative design elements and technical background of each student in the creation of collaborative design projects with the intention of giving students real-world, problem-based design experience. (Writing Intensive Course)

**Attributes:** CWIC – Core, Skills, WIC

**WSE 425. TIMBER TECTONICS IN THE DIGITAL AGE. (4 Credits)**

An exploration of the advances in design, construction and fabrication of timber buildings. Includes experimentation with both physical and digital models and a final project, in collaboration with UO Architecture students. Lec/lab/studio.

**Recommended:** Junior standing and knowledge of CAD

**WSE 430. FUNDAMENTALS OF ENGINEERING MECHANICS. (4 Credits)**

An introduction to fundamentals of engineering mechanics for RM students selecting Science and Engineering option. While in most aspects the course follows standard introductory mechanics courses for engineers, special attention is paid to elasticity and strength in cellular and anisotropic materials like solid wood and bio-based composites. The overall objective of this course is to provide fundamental knowledge and practical skills in the area of engineering mechanics and mechanical principles behind some of the most important methods of characterization, processing, and utilization of renewable biomaterials; commonly used today, emerging and future. Lec/lab.

**Prerequisites:** MTH 254 with D- or better and WSE 324 [B-]

**WSE 444. STRAND-BASED COMPOSITES MANUFACTURE. (1 Credit)**

The strand-based composites manufacturing process uses the results of research projects and the instructor's mill experience. All aspects of the process from wood procurement through pressing are discussed. This course will be valuable to those interested in a manufacturing career.

**WSE 450. ENTREPRENEURIAL PRODUCT DEVELOPMENT I. (3 Credits)**

Provides an entrepreneurial experience in product development, in which students design, produce, market, and sell a product in a business setting. Working as a team, students will design a product using renewable materials and are expected to perform and understand manufacturing techniques and processes to produce the product in limited quantities.

**Prerequisites:** WSE 250 with C- or better and WSE 455 [C-]

**WSE 451. ENTREPRENEURIAL PRODUCT DEVELOPMENT II. (3 Credits)**

Provides an entrepreneurial experience in product development, in which students design, produce, market, and sell a product in a business setting. Working as a team, students will design a product using renewable materials and are expected to perform and understand manufacturing techniques and processes to produce the product in limited quantities. Lab/studio.

**Prerequisites:** WSE 250 with C- or better and WSE 450 [C-] and WSE 455 [C-]

**WSE 453. ^FOREST PRODUCTS BUSINESS. (3 Credits)**

Provides students with the skills necessary to operate effectively in the global forest products industry. (Writing Intensive Course)

**Attributes:** CWIC – Core, Skills, WIC

**Recommended:** ECON 201 and ECON 202

**WSE 455. INDUSTRIAL MARKETING IN THE FOREST SECTOR. (3 Credits)**

Marketing relies heavily on effective communication, so this course concentrates on written and oral communication. The course will arm students with the skills necessary to apply basic concepts of marketing of forest products. Application will be highlighted through examples and industry speakers relating course work to the day-to-day work in business.

**WSE 458. DESIGN OF WOOD STRUCTURES. (3 Credits)**

Study of basic wood properties and design considerations. Design of wood connectors, beams, columns, and beam columns. Introduction to plywood and glue laminated members. Design of structural diaphragms and shear walls. Taught via Ecampus only.

**Prerequisites:** CE 381 with C or better

**WSE 461. BIO-BASED PRODUCTS MANUFACTURING. (4 Credits)**

First of a 3-term series exploring technologies and management practices associated with manufacturing products from wood and other renewable materials. Subjects covered include the major processing steps for the conversion of raw materials such as wood, bamboo, hemp, and cereal straws into products.

**Prerequisites:** WSE 210 with C- or better and WSE 321 [C-] and WSE 324 [C-]

**WSE 462. ADVANCED MANUFACTURING 1. (4 Credits)**

Second of a 3-term series exploring technologies and management practices associated with manufacturing products from wood and other renewable materials. Subjects covered include process design elements, quality control, and approaches to continuous process improvement.

**Prerequisites:** WSE 461 with C- or better

**WSE 463. ADVANCED MANUFACTURING 2. (4 Credits)**

Third of a 3-term series exploring technologies and management practices associated with manufacturing products from wood and other renewable materials. Subjects covered include process control, optimization, automation, and contemporary topics such as Big Data and the Internet of Things and the potential impacts of the trends on manufacturing enterprises.

**Prerequisites:** WSE 462 with C- or better

**WSE 465. RENEWABLE MATERIALS MANUFACTURING EXPERIENCE. (2 Credits)**

Learning about and visiting a number of renewable materials industrial and commercial operations representing all parts of the renewable materials value chain. The class will meet daily for one 5-day week immediately prior to the start of fall term. During the week, the students and at least one instructor will meet daily. Lectures will precede visits to industrial plants, mills and sites. At the end of the day, an instructor will participate in a debriefing session, reiterating what was learned during the day. Students will then submit a report on the day's activities. The class includes daily travel and overnight stays.

*This course is repeatable for 4 credits.*

**WSE 470. \*FORESTS, WOOD, AND CIVILIZATION. (3 Credits)**

Multidisciplinary examination of issues related to the roles of forests, trees, and wood in civilization, as providers of commodities, ecosystem services, and spiritual and artistic inspiration. Issues include global supply and demand, wood ownership and political power, and perceptions and uses of forest resources in different societies. (Bacc Core Course)

**Attributes:** CSGI – Core, Synth, Global Issues

**Equivalent to:** WSE 470H

**WSE 470H. \*FORESTS, WOOD, AND CIVILIZATION. (3 Credits)**

Multidisciplinary examination of issues related to the roles of forests, trees, and wood in civilization, as providers of commodities, ecosystem services, and spiritual and artistic inspiration. Issues include global supply and demand, wood ownership and political power, and perceptions and uses of forest resources in different societies. (Bacc Core Course)

**Attributes:** CSGI – Core, Synth, Global Issues; HNRS – Honors Course Designator

**Equivalent to:** WSE 470

**WSE 471. RENEWABLE MATERIALS IN BUILDING CONSTRUCTION. (3 Credits)**

Building construction is a major application of renewable materials, primarily wood. This course explores material selection options, applications, and performance characteristics. Residential construction is emphasized, but non-residential construction applications will also be discussed. Concepts and interpretation of life cycle assessment are introduced.

**WSE 473. BIOENERGY AND ENVIRONMENTAL IMPACT. (3 Credits)**

Explores world's use of woody biomass fuels, their potential to contribute to our region's energy supply, and conversion technologies such as direct combustion, pyrolysis, and thermochemical modification. Also examines emissions and other environmental impacts of utilizing renewable materials to generate energy and manufacture products.

**Prerequisites:** ((MTH 111 with D- or better or MTH 112 with D- or better or MTH 231 with D- or better or MTH 241 with D- or better or MTH 245 with D- or better or MTH 251 with D- or better or MTH 251H with D- or better) and (CH 122 [D-] or CH 222 [D-] or CH 232 [D-] or CH 232H [D-]))

**WSE 475. ENVIRONMENTAL ASSESSMENT OF BUILDING MATERIALS. (4 Credits)**

Study of sustainability in the built environment from a building material perspective. Understanding the ecology of building materials and assessing their environmental sustainability performance using life cycle analysis. Critical discussion of case studies and future of LCA in the built environment.

**WSE 499. SPECIAL TOPICS. (0-16 Credits)**

*This course is repeatable for 99 credits.*

**WSE 501. RESEARCH AND SCHOLARSHIP. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 503. THESIS. (1-16 Credits)**

*This course is repeatable for 999 credits.*

**WSE 505. READING AND CONFERENCE. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 506. PROJECTS. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 507. SEMINAR. (1 Credit)**

Section 1: Beginning Seminar. Section 2: Seminar. Graded P/N.

*This course is repeatable for 99 credits.*

**WSE 513. WOODTURNING WITH SCIENCE II. (4 Credits)**

An in-depth look at how character in wood (figure, spalting, knots, etc.) affects machinability and output in both functional and aesthetic turning. Students will work with a wide range of spalted wood types and figure across numerous species while working on advanced turning forms. Particular emphasis will be placed upon how figure affects grain orientation, how spalting affects density and stability, and how the challenges with character wood can be overcome without specialty tools. Class instruction will be entirely studio based.

*This course is repeatable for 12 credits.*

**Recommended:** WSE 210 and WSE 211

**WSE 514. ART AND DESIGN CAPSTONE. (4 Credits)**

For the final term of a student's last year in the Renewable Materials Industrial Design program, this course brings together the basic collaborative design elements and technical background of each student in the creation of collaborative design projects with the intention of giving students real-world, problem-based design experience.

**WSE 516. INTRODUCTION TO SCULPTURAL WOODTURNING. (4 Credits)**

The development of studio / sculptural woodturning has a unique history, and involves a cluster of specialized skills. This course blends historic woodturning practices with modern approaches and aesthetics to bring an understanding of wood science into this very specialized field of woodturning.

**Prerequisites:** WSE 513 with B or better and WSE 514 [B]

*This course is repeatable for 12 credits.*

**WSE 520. THE GLOBAL CONTEXT OF THE FOREST SECTOR. (3 Credits)**

Provides a broad knowledge base of business and marketing practices in the global forest industry. Includes a module on research ethics that fulfills OSU Graduate School requirements.

**WSE 521. WOOD SCIENCE I. (4 Credits)**

A comprehensive overview and integration of wood anatomy, wood physics, wood chemistry and wood mechanics; global contemporary issues impacting the wood and fiber sector; integration of basic wood sciences to understand the complex relationships between environment and wood material properties, and the influence of both on the use of wood-based materials.

**WSE 522. WOOD SCIENCE II. (4 Credits)**

Continuation of the comprehensive overview and integration of wood and fiber anatomy, physics, chemistry, and mechanics; integration of basic wood science to understand relationships with wood and fiber properties and their impact on final use. Focus on biological, chemical and physical degradation of wood; adhesion; and physical and engineering properties of wood. Lec/lab.

**WSE 525. TIMBER TECTONICS IN THE DIGITAL AGE. (4 Credits)**

An exploration of the advances in design, construction and fabrication of timber buildings. Includes experimentation with both physical and digital models and a final project, in collaboration with UO Architecture students. Lec/lab/studio.

**Recommended:** Knowledge of CAD

**WSE 526. STRUCTURAL HEALTH ASSESSMENT/MONITORING OF TIMBER BUILDINGS. (3 Credits)**

Holistic approaches for the evaluation of the performance of timber systems and structures in a building. Learn about the tools available to experts for different analysis purposes, and to understand how data acquired from different techniques can be analyzed and used to inform building management and maintenance, fabrication and construction practices, and future design.

**WSE 530. POLYMER COMPOSITES. (3 Credits)**

A comprehensive survey of the material and mechanical properties of polymer-based composite materials including failure mechanisms, interfacial and nanoscale effects, and transport and thermal properties.

**Recommended:** CHE 545 and multivariable calculus

**WSE 535. POLYMER SYNTHESIS AND STRUCTURE. (3 Credits)**

A comprehensive overview of various synthetic methods for various synthetic polymers; structures of various synthetic and natural polymers.

**Recommended:** 3 credits of undergraduate organic chemistry or CH 331 or CH 334

**WSE 553. FOREST PRODUCTS BUSINESS. (3 Credits)**

Provides students with the skills necessary to operate effectively in the global forest products industry.

**Recommended:** ECON 201 and ECON 202

**WSE 555. INDUSTRIAL MARKETING IN THE FOREST SECTOR. (3 Credits)**

Marketing relies heavily on effective communication, so this course concentrates on written and oral communication. The course will arm students with the skills necessary to apply basic concepts of marketing of forest products. Application will be highlighted through examples and industry speakers relating coursework to the day-to-day work in business.

**WSE 558. WOOD DESIGN. (4 Credits)**

Study of basic wood properties and design considerations. Design and behavior of wood connectors, beams, columns and beam columns. Introduction to plywood and glue laminated members. Analysis and design of structural diaphragms and shear walls. Lec/lab. CROSSLISTED as CE 584.

**Equivalent to:** CE 584

**Recommended:** CE 383 or CE 481 with minimum grade of C

**WSE 561. BIO-BASED PRODUCTS MANUFACTURING. (4 Credits)**

First of a 3-term series exploring technologies and management practices associated with manufacturing products from wood and other renewable materials. Subjects covered include the major processing steps for the conversion of raw materials such as wood, bamboo, hemp, and cereal straws into products.

**Recommended:** WSE 210 and WSE 321 and WSE 324

**WSE 562. ADVANCED MANUFACTURING 1. (4 Credits)**

Second of a 3-term series exploring technologies and management practices associated with manufacturing products from wood and other renewable materials. Subjects covered include process design elements, quality control, and approaches to continuous process improvement.

**Recommended:** WSE 461

**WSE 563. ADVANCED MANUFACTURING 2. (4 Credits)**

Third of a 3-term series exploring technologies and management practices associated with manufacturing products from wood and other renewable materials. Subjects covered include process control, optimization, automation, and contemporary topics such as Big Data and the Internet of Things and the potential impacts of the trends on manufacturing enterprises.

**Recommended:** WSE 462

**WSE 571. RENEWABLE MATERIALS IN BUILDING CONSTRUCTION. (3 Credits)**

Building construction is a major application of renewable materials, primarily wood. This course explores material selection options, applications, and performance characteristics. Residential construction is emphasized, but non-residential construction applications will also be discussed. Concepts and interpretation of life cycle assessment are introduced.

**WSE 573. BIOENERGY AND ENVIRONMENTAL IMPACT. (3 Credits)**

Explores world's use of woody biomass fuels, their potential to contribute to our region's energy supply, and conversion technologies such as direct combustion, pyrolysis, and thermochemical modification. Also examines emissions and other environmental impacts of utilizing renewable materials to generate energy and manufacture products.

**Recommended:** (MTH 111 or MTH 112 or MTH 231 or MTH 241 or MTH 245 or MTH 251 or MTH 251H) and (CH 122 or CH 222)

**WSE 575. ENVIRONMENTAL ASSESSMENT OF BUILDING MATERIALS. (4 Credits)**

Study of sustainability in the built environment from a building material perspective. Understanding the ecology of building materials and assessing their environmental sustainability performance using life cycle analysis. Critical discussion of case studies and future of LCA in the built environment.

**WSE 592. ADVANCED WOOD DESIGN. (4 Credits)**

Study of advanced concepts in wood properties and design. Design and analysis of specialty wood connectors. Design of wood members for adverse conditions including fire design. Common failure mechanisms and forensic engineering concepts. Design for durability. Lec/lab.

**Recommended:** Understanding of basic concepts in mechanics and timber design

**WSE 599. SPECIAL TOPICS. (0-16 Credits)**

*This course is repeatable for 99 credits.*

**WSE 601. RESEARCH AND SCHOLARSHIP. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 603. THESIS. (1-16 Credits)**

*This course is repeatable for 999 credits.*

**WSE 605. READING AND CONFERENCE. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 606. PROJECTS. (1-16 Credits)**

*This course is repeatable for 16 credits.*

**WSE 607. SEMINAR. (1 Credit)**

Section 1: Beginning Seminar. Section 2: Graduate Seminar.

*This course is repeatable for 99 credits.*

**WSE 699. SPECIAL TOPICS. (1-16 Credits)**

*This course is repeatable for 16 credits.*