UNIVERSIDADE DOS AÇORES

Academic Syllabus

1. Name of the course

- EN: Sustainable Materials for a Circular Future
- PT: Materiais Sustentáveis para um Futuro Circular

2. Work hours /ECTS

Contact hours		Total work hours	ECTS	US Credits
Theoretical	14			
Theoretical-practical	7			
Lab	7	145 (USA equiv 45)	6	3
Seminar	6			
Field work	8			
Internship	0			
Tutorial guidance	0			

3. Teachers responsible for the course

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4. Course description

Island nations are at the forefront of ecological transformation and climate change, as their geography makes them particularly vulnerable to rising sea levels. At the same time, their remoteness often implies a high degree of local autonomy. As the urgency of resilience grows, islands have the potential to act as incubators and leaders of environmentally driven futures. The Portuguese volcanic islands of the Açores are one such example. Situated along the Mid-Atlantic Ridge—where the European, African, and American tectonic plates meet—the archipelago occupies a liminal position: part of Portugal, at the western edge of the European Union, and deeply connected to New England through waves of emigration.

In this four-week summer course, students will begin by exploring the ecosystems of São Miguel Island, the largest of the Açorean islands, through a series of hikes accompanied by weekly drawings and paintings. The course will then shift to an exploration of local biomaterials for architecture through seminars, laboratory experiments, and fieldwork.

For centuries, biofibers were among the primary materials used in the making of everyday objects and building components. With the advent of plastics and other synthetic materials in the early twentieth century, the use of natural materials declined. Today, however, growing environmental awareness and new material attitudes have prompted their reconsideration in innovative ways. Students will observe craft traditions and examine the intersections of ecology and contemporary cultural practices by engaging with local ecologists, designers, and artists. They will learn how local agricultural byproducts and invasive plant species can be transformed into biofiber mixtures using multiple processing techniques, including weaving, pressed composites, and 3D printing, for a range of architectural applications.

Following this material experimentation, students will participate in the full-scale construction of a demonstration project by building a portion of a butterfly pavilion. The pavilion will be located at Quinta Bio Kairós Malaca, a large regenerative organic farm within the Kairós network. The site demonstrates multiple sustainable strategies and serves as a vital ecological and educational resource for both the farm and the island. The farm functions both as a center for syntropic organic agriculture and as a social initiative supporting individuals at risk of exclusion. The pavilion itself will serve as an educational space designed to attract and protect butterflies and bees, supporting biodiversity, research, and public engagement. It will incorporate site-based materials, including a 70 m² biofiber-netted habitat and an 18 m² nursery lab constructed from carbon-sequestering materials.

5. Learning outcomes

OBJECTIVES

This course's main purpose is to introduce students to:

1. Ongoing research into the rapidly evolving world of sustainable materials,
2. The different characterization methods of materials to understand their advantages and disadvantages,
3. The rapidly evolving world of bio-design in replacing petroleum-based products,
4. Working in Hybrid laboratory / material production to learn approaches to bio-design,
5. Understand the implications that sustainable materials have in the ecosystem and circular economy.

LEARNING OUTCOMES

By the end of this course students will develop:

1. A deeper understanding of sustainable materials,
2. The ability to analyze the properties of different materials and design with this knowledge,
3. Fluency in understanding the foundational ecological framework,
4. Development of critical thinking and practical skills,
5. A personal stance open to re-evaluation through lab-based research methods,
6. Familiarity with the research and the debates of leading thinkers in sustainable materials,
7. Collaborative skills across disciplines.

6. Outline Schedule

Week 1:
- Class overview and meet with the partners from University of Açores, Bio Kairos, and Vaga,
- Seminars on Açores Ecology, bio-design and Portuguese design culture,
- Island explorations,
- Critique of weekly paintings.

Week 2:
- Lab work at the University of Açores using minerals, biofibers + invasive plant materials,
- Seminars on material characteristics and processing,
- Workshops on biogenetic fabrication,
- Island explorations,
- Critique of weekly drawings at the Arquipélago Arts Center.

Week 3:
- Build Workshop – assembly of biogenetic wall assemblies for butterfly pavilion lab,
- Assembly of prototype of living retaining wall,
- Island explorations,
- Critique of weekly paintings.

Week 4:
- Build Workshop – assembly of biogenetic wall assemblies for butterfly pavilion lab,
- Exhibition preparation,
- Final exhibit at Vaga with community members, Kairos, and Portuguese guests.

7. Content

SEMINAR CLASSES

1.1 Introduction to Açorian Ecosystem: Overview and history of endemic and invasive species.
1.1 Introduction to Sustainable Materials: Overview of sustainable materials; Historical context and development.
1.2 Bio-design Principles: Definition and significance; Key concepts and strategies.
1.3 Methods of Material Characterization: Mechanical, thermal, and chemical-physical properties; Testing methods and standards.
1.4: Introduction to sustainable planning networks for environmental management and renewable infrastructure.
1.5 Circular Economy Principles: Definition and importance; Key strategies and frameworks
1.6 Sustainable Material Innovations: Emerging technologies and case studies; Challenges and opportunities.

THEORETICAL-PRACTICAL LAB CLASSES

2.1 Synthesis and Production: Synthesis of biopolymers; Production techniques for sustainable materials.
2.2 Property Analysis of Materials: Testing mechanical properties; Analyzing thermal stability.
2.3 Thermodynamics and Kinetics in Material Science: Thermodynamic principles in material stability; Kinetics of material transformations.
2.4 Testing New Materials: Combining different fibers and polymers; Experimentation with fillers and additives.
2.5 Bio-design in Practice: Creating bio-designed products; Evaluating bio-design efficacy.
2.6 Comparative Studies of Sustainable Materials: Comparing properties and performance; Evaluating environmental impact.

FIELD WORK

3.1 Guided walks that introduce local biology, geology and ecosystems.
3.2 Workshops with local artisans and designers.
3.3 Bio-Material workshops demonstrating an array of biofiber and soil/mineral mixes.
3.4 Construction of prototype of Bio-Based Retaining Wall: construction of a segment of a retaining wall system using nature-based solutions—aggregate tiles, bamboo pins, and hemp netting—to stabilize slopes (and to replace carbon-intensive concrete and steel).
3.5 Construction of Bio-Based Walls: construction of a hybrid wall system that combines lime and local bio-fiber hurd from local waste streams with triangulated wood framing. The system forms a rigid, insulating high-performance, and healthy wall assembly that insulates and passively moderates solar gain. A set of bio-based exterior tiles will be made by each student.
3.6 Practical Project Development: Developing and presenting a collaborative sustainable project.

8. Demonstration of the syllabus' coherence with the course's learning outcomes

The seminar classes will allow students to develop a deep understanding of the course content and will serve as their introduction to the topics described. In the laboratory, students will take a hands-on approach to producing materials and analyzing their properties. In the workshops, students will develop production processes to create full-scale material samples by mixing different types of fibers, fillers, and polymers. During the fieldwork component, students will be asked to produce a prototype using the biomaterials they have studied. Together, the fieldwork and seminar sessions will give students a broader understanding of sustainability and materials while allowing them to evaluate best practices.

9. Teaching methodology

- Lectures introducing theoretical concepts,
- Practical laboratory sessions for hands-on experience,
- Daily sketch book to capture observations and generate thought,
- Painting exploration to synthesize learning into a series,
- Material workshops in the field,
- Field visits to observe and learn from real-world applications,
- Seminars for in-depth exploration of specific topics.

10. Assessment

- Formative assessment (oral interaction, desk crits): 20%
- Intermediate assessment (Research Assignments): 30%
- Final assessment (Final Project): 50%

11. Demonstration of the coherence between the teaching methodologies and the learning outcomes

All learning outcomes will be addressed either by the laboratory work, research assignments, desk crits, and oral interaction in and out of the classes.

12. Bibliography

Bibliography for reference purposes, selected readings will be assigned with seminar lectures.

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- Vasconcelos, H.C., Eleutério, T. (2023). Sustainable Materials for Advanced Products. In: Leal Filho, W., Azul, A.M., Doni, F., Salvia, A.L. (eds) Handbook of Sustainability Science in the Future. Springer, Cham. https://doi.org/10.1007/978-3-031-04560-8_42