Courses content of the second semester at AgroParisTech

Course title: Bioenergies and lignocelluloses

Key words	lignocelluloses, biorefinery, value chain, products quality, wood, energy
Aims	Lignocelluloses biochemical and agronomic specificities are at the origin of their diversified non-food uses. They are a biomass of choice for the production of energy and materials according to the climate-energy strategies. Understanding their specificities and the different levers of their quality is necessary to unlock bottlenecks hindering some uses. In this context, the aims of this module are: • Present the main value chains relative to the use of lignocelluloses and the associated R&D activities (energy, materials, chemistry) • Integrate the agronomic, biochemical and technological aspects in relation to lignocellulose biorefineries • Identify the current bottlenecks limiting the development of some transformation routes • Analyse the stakes of using lignocelluloses as raw material, with or without any fractionation
Content	Lectures: • Introduction (1,5h) • From paper industry to lignocellulose biorefinery: towards a multicriteria approach of quality (3h) • Energetic crops and biomass (3h) • Lignocelluloses and fibers (1,5h) Visits: • R&D centers (IFPEN Biotechnologies division, FRD center) (6h) • Production unit (Greenfield paper recycling unit) (3h) • Research laboratory (INRA unit in plant sciences) (3h)
ECTS	**2**
Skills	Knowledge and understanding For a passing grade the student must • Know the composition and structure of lignocellulose and their main conversion routes in materials, molecules and energy • Understand the factor governing their quality • Be aware of the current challenges associated to lignocellulose biorefinery and the different possible technological levers • Understand the research and innovation strategies relative to lignocellulose Competences and skills For a passing grade the student must • Develop integrated approach of lignocellulose uses • Be able to implement a multi-criteria analysis

	Judgement and approach For a passing grade the student must • Analyse the complementarity and connection between different research and innovation approaches
Complementary skills	Capacity to design R&D project structures, capacity to interact with professional staff of the sector (research, R&D, production), capacity to make a written synthesis of different visits
Module Coordinator(s)	Stéphanie Baumberger
Teaching staff	Stéphanie Baumberger, Benoit Gabrielle, Hermann Höfte (INRA, IJPB)
Language of instruction	English
Nb hours of lectures	9
Nb hours of practical work	
Nb hours of tutorials	
Nb hours of personal work	3
Nb hours of other	12
Length of the internship in weeks	
Bibliography recommended	FitzPatrick et al. (2010) A biorefinery processing perspective: Treatment of lignocellulosic materials for the production of value-added products. Biores Technol, 101, 1915-1922; Hongzhang (2015) Lignocellulose biorefinery engineering, 1st Edition, Elsevier; De Bowhmick et al. (2018) Lignocellulosic biorefinery as a model for sustainable development of biofuels and value added products. Biores Technol, 1144-1154.
Prerequisites	Knowledge in biochemistry
Teaching period (when)	S2 – 3rd week of February
Place of teaching (where)	AgroParisTech, Université Paris-Saclay
Assessment	Individual synthetic report on the visits, including the comparison of the different structures and their research and innovation approaches.

Course title: Biomass Resources and Territories

Key words	Agriculture, Soil, Energy and nutrient supply, agricultural production systems, territorial metabolism
Aims	Biomass resources are produced from recent photosynthesis as plant or animal outputs. This module will aim at describing the complex agricultural systems leading to biomass production within territories. It should give some insights regarding the biological processes interacting with the driving stakeholders leading to material and immaterial fluxes. Territorial ecology will be defined and used as the encompassing conceptual framework.
Content	Lectures on biomass resources production (definition, quantification and characterization); on required fluxes for biomass production (energy, nutrient, water, …) and on the actors networks

	Practical work i) on building conceptual and mathematical models on biomass production ii) on using existing tools regarding biomass quantification and impact assessment On field trip in the Western part of France Tutored collective work on a case study of biomass production
ECTS	**6**
Skills	Knowledge and understanding For a passing grade the student must • Know how some biomasses from agriculture are produced • Know which fluxes are usually required for biomass production • Understand the structure of the agricultural system involved in biomass production • Understand the role of some stakeholders involved in biomass production Competences and skills For a passing grade the student must • Review sets of papers to provide a short synthesis on the treated topic regarding biomass production • Build simple qualitative and/or quantitative models representing a territorial metabolism. • Analyse simple metabolic networks on territorial biomass production Judgement and approach For a passing grade the student must • Critically evaluate the sustainability of biomass production in some territories • Propose changes to improve the above quoted sustainability
Module Coordinator(s)	Philippe Lescoat, AgroParisTech
Teaching staff	AgroParisTech : Benoit Gabrielle, Chantal Loyce, Nicolas Guilpart, Thierry Bonaudo, Solène Pissonnier, University of Technology of Troyes : Sabrina Brullot, Pauline Marty University of Paris : Petros Chatzimpiros
Language of instruction	English
Nb hours of lectures	12
Nb hours of practical work	12
Nb hours of tutorials	12
Nb hours of personal work	6
Nb hours of other	6 (on field trip)
Length of the internship in weeks	0
Bibliography recommended	
Prerequisites	Bachelor in life sciences
Teaching period (when)	End of February – Beginning of March
Place of teaching (where)	Paris (2021) and Palaiseau (afterwards)

Assessment	Individual written exam on the lectures content (25% of the grade) Individual short report on the on field trip (10% of the grade) Collective (maximum of 3 students) work (10 pages report) and oral presentation (30 minutes) on a biomass production issue (65% of the grade)

Course title: Decision Aiding, Operation Research and Sciences for innovation

Key words	Decision, Operation Research, Sciences for Innovation, New Business model.
Aims	• In a digital age, **Facing up** the complexity of science-based decision-making, in an organization that is adapting its internal environment to its external environment. • **Understanding** the process of innovation (leading from a new idea, a new object, a new tool or a new behavior to its widespread acceptation and application) and the **ability** to develop a new business model. • Group-work **aptitude**
Content	**Decision Aiding**: an introduction to Decision-Making theories and applications (strategy, scientific tools, knowledge and human behaviour). **Operation Research**: modelling and problem solving (basics, role, scope, models and applications such as 'transportation problem' or 'assignment problem', 'dynamic programming', 'network models' or 'queuing models'). **Introduction to Sciences for Innovation**: theories, methods and applications especially for designing new business models.
ECTS	**3**
Skills	Knowledge and understanding For a passing grade the student must • Decision aiding, history, great theories and applications • Operation Research, history, great theories and applications. • Sciences for innovation (especially new Business Model) Competences and skills For a passing grade the student must • Drawing a Great (Digital) Strategy • Modelling and Problem Solving • Drawing new Business Models Judgement and approach For a passing grade the student must • Reflexivity on one's position when facing up a complex situation (in a Digital age) and on one's strategic move. • Collective learning, move and behaviour.
Module Coordinator(s)	Gilbert GIACOMONI
Teaching staff	Gilbert GIACOMONI ; Edouard THISSE

Language of instruction	English
Nb hours of lectures	16
Nb hours of practical work	8
Nb hours of tutorials	
Nb hours of personal work	
Nb hours of other	
Length of the internship in weeks	
Bibliography recommended	• Nakhla M. et Moisdon J.-C., (2010), *Recherche opérationnelle. méthodes d'optimisation en gestion*. Presse Des Mines. • Natarajan A. M., (2014), Operations Research, 2nd Edition, Pearson India. • Tsoukias A., (2003), From Decision Theory to Decision aiding Methodology, LAMSADE. • Giacomoni G., (2019), "Introduction to Sciences for Innovation", (HAL course online). • Giacomoni G., (2018), Constructing New Representations and the Implications for Decision Making Theory: Learning from Archimedes, European Management Review, 16(1). • Osterwalder A. et Pigneur Y., (2010), Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Editor John Wiley & Sons Ltd.
Prerequisites	Master 1 Level
Teaching period (when)	February (first week)
Place of teaching (where)	
Assessment	Coaching exercises and group work

Course title: Economic tools for environmental analysis

Key words	Economics, environment, climate change, biodiversity
Aims	This EU aims at acquiring economic tools to address issues related to environmental, ecological and climatic issues.
Content	The teaching unit is composed with the following modules: • Fundamentals of Microeconomic Analysis: The Basics of Consumer and Producer Theory; • Bio-economy: economics of biomass, bioenzymes, bioplastics and bioenergy • Economic calculus: notions of discount rate and temporal preferences; • Optimal use of renewable resources: study of fisheries and forest management problems; • Economics of risk and innovation: risk and climate change, development of so-called green innovations; • Growth and the environment: lifestyles and future prospects around economic growth in the context of global warming;
ECTS	**6**
Skills	Knowledge and understanding For a passing grade the student must • Complete the basics of microeconomics

	• Understand the notion of risk in economics and how it is applied to climate change • Understand bio-economy • Compute discounting calculus • Understand the challenges of renewable resources management • Contextualize its knowledge in light of the trade-off between economic growth and limited resources Competences and skills For a passing grade the student must • Develop a global approach of economic modelling • Read economic results • Analyse the trade-off between environment and economy • Making use of economic tools to provide answers to environmental questions Judgement and approach For a passing grade the student must • Propose and evaluate public policies related to climate change
Module Coordinator(s)	Julien Wolfersberger
Teaching staff	Julien Wolfersberger, Jean-Christophe Bureau, Antonello Lobianco, Caroline Orset, Joël Priolon
Language of instruction	English
Nb hours of lectures	
Nb hours of practical work	
Nb hours of tutorials	
Nb hours of personal work	
Nb hours of other	
Length of the internship in weeks	
Bibliography recommended	Perman, R., Ma, Y., McGilvray, J., & Common, M. (2003). Natural resource and environmental economics. Pearson Education. Varian, H. R. (2015). Introduction à la microéconomie moderne. De Boeck Supérieur
Prerequisites	Basic notions of mathematics
Teaching period (when)	S2 – 2ième et 3ième semaines de Février
Place of teaching (where)	AgroParisTech, Université Paris-Sacaly
Assessment	

Course title: Environmental Assessment for a sustainable bio-economy

Keywords	Sustainability assessment, environmental impacts, environmental management, life-cycle assessment, value-chain, bio-economy
Aims	The course aims at raising students' awareness of complementary approaches applicable to the management of ecosystems and of bio-based

	value-chains in general: the ecosystem services framework, and metabolism and life-cycle approaches. Course attendants will get to grips with the principles of these approaches, gain insight from their application to agricultural systems and bio-based value-chains, and gain practical know-how on how to apply them hands-on to different case-studies. They will become familiar with environmental management, the ISO 14 000 standards and the principles of their implementation in various decision-making contexts to improve the environmental performance of production systems or organizations. The course will equip students with the tools and methods currently used in this process for the environmental assessment of products and services, and their eco-design. Life-cycle assessment, whose use is currently spreading in all economic sectors for purposes of eco-design, consumer information or policy design, will occupy a central place in the pedagogy.
Content	Lectures on the principles of environmental management at product, value-chain, organization or territorial level; introduction to several methodological frameworks: ecosystem services, life-cycle assessment, territorial metabolism and industrial ecology. Application to the bio-economy and the various stages of products' life-cycles. Group work on cases proposed by the teaching staff (examples related to processes or topic covered in the other courses: lignocellulose production with dedicated crops, 2G ethanol in Europe, lignin valorisation, micro-algae production and wastewater treatment, ...)
ECTS	**4**
Skills	Knowledge and understanding For a passing grade the student must • know the principles of environmental management and assessment in the context of the bio-economy • be familiar with the main steps of environmental assessment methods Competences and skills For a passing grade the student must • be able to diagnose the main environmental issues associated with bio-based processes and propose methods to address them • be able to apply life-cycle assessment to bio-based value-chains Judgement and approach For a passing grade the student must • ……
Module Coordinator(s)	Consulting professor (to be determined) ; Benoit Gabrielle (AgroParisTech) for now
Teaching staff	To be determined (may include LNEG staff for project work)

Language of instruction	English
Nb hours of lectures	9
Nb hours of practical work	27
Nb hours of tutorials	3
Nb hours of personal work	
Nb hours of other	
Length of the internship in weeks	
Bibliography recommended	To be determined (will be provided on the e-learning platform of the course)
Prerequisites	Basic knowledge of bio-economy processes (feedstock production, conversion pathways for biomaterials, bioenergy or bio-molecules purposes)
Teaching period (when)	
Place of teaching (where)	Paris and Saclay
Assessment	Report and oral defence of group work on the assessment of a bio-based project

Course title: Interculturality and creativity

Key words	Innovation, multi-actors approach, creativity, cultural diversity
Aims	Innovation in Bioeconomy is more and more driven by multi-actors approaches involving groups mixing people and stakeholders from different disciplines, sectors, cultures and points of view. The diversity of these groups is source of creativity and innovation provided the interculturality can be manage in a constructive way. In this context, the aims of this course is: • To provide some tools for the management of interculturality • To illustrate how to work in groups within creative projects • To put into practice some tools through case study situations
Content	Lectures: • Innovation and creativity: thinking outside the box. What does it mean, when and how it happens (3 h) • All together within creative projects: what should we do, why, what for, who, when and how (3 h) • Making the most of cultural diversity in team work (3 h) • *Convincing stakeholders for business development (3h)* • *Entrepreneurship (3 h)* Study cases on “making profit of cultural diversity in team” (3 h)
ECTS	**3**
Skills	• to analyse difficulties and find way to overcome them; • to implement tools for working in groups; • to be aware of cultural diversity in a group and make profit of it
Complementary skills	Capacity of self-assessment
Module Coordinator(s)	Stéphanie Baumberger, Sophie Landaud, Ghislaine Tamisier
Teaching staff	Laurence Prévosto (INRA), Grégoire Burgé (AgroParisTech), Ghislaine Tamisier, Judith Ellison (AgroParisTech), Loic-Rajjou (AgroParisTech), Participant from the SATT Paris-Saclay

Language of instruction	English
Nb hours of lectures	18h
Nb hours of practical work	3h (assessment)
Nb hours of tutorials	3h
Nb hours of personal work	-
Nb hours of other	-
Length of the internship in weeks	-
Bibliography recommended	-
Prerequisites	None
Teaching period (when)	S2 – all along the semester
Place of teaching (where)	AgroParisTech, Université Paris-Saclay
Assessment	Individual interviews

Course title: Green Line Project – 2nd stage

Key words	Biotechnology, bioeconomy, innovation, biomolecules, biorefining, life cycle analysis, white biotechnologies, fractioning, extraction, functional properties, biological activity, chemical intermediates, industrial microbiology, downstream processing, biomass, sustainable chemistry

Aims	• Implement scientific knowledge in biochemistry, biophysics, microbiology, process engineering applied to the valorisation of biomass resources in bioindustries
	  ○ Define a 6 weeks project for testing technological feasibility of a given green line project
	  ○ Develop an experimental strategy at the laboratory scale, realize experimentations and analyse results
	  ○ process scale-up
	  ○ Evaluate outcomes
	• Identify economic and market data for preliminary evaluation of the feasibility of the green line project
	• Conduct preliminary life cycle analysis and evaluation of feasibility
	• Know and implement tools of project management

Content	The valorisation of renewable resources, i.e. biomass in the large sense, is on the base of the bioeconomy. Biomass constitutes a source of molecules, macromolecules and supramolecular assemblies which can be used in numerous applications of virtually every industrial domain, such as food and cosmetics industry, chemicals, materials and textile industries, pharmaceuticals and biomedicine. For that, strategies of deconstruction of complex biological tissues need to be employed, using mechanical, chemical, enzymatic (biotechnological) methods. To give some examples, such methods can be employed to fabricate natural antioxidants, pigments, thickening agents, surfactants, lubricants, solvents, materials, composites. White biotechnology or green chemistry can be employed to re-assemble biobased building blocks to substances or assemblies of designed function, such as polymers, fragrances, pharmaceuticals, chemicals. The green line projects concern real case applications in this domain, such as the development of deconstruction strategies of a given plant for the

	fabrication of functional polysaccharides, the design of a biorefinery of microalgae, the valorisation of agricultural by-products in the cosmetics industry, to name but a few. A group of 2-3 students, formed during the first stage of the green line project in S1, will investigate a specific technological question and use basic economic and environmental evaluation tools for a preliminary test of feasibility of the concept. The module consists in: • Lecture on project management tools • Lectures on intellectual property and patent research • Lectures on demand concerning specific technological needs of a given green line project • Industrial conferences and visits on industrial sites related to the green line project • Tutored literature research and synthesis writing • Tutored development of an experimental project strategy • Experimental work at the laboratory scale • Writing up of a project report and preparing an oral presentation. The oral presentation will be a basis of the presentation of the green line project in the Bioceb Summer School.
ECTS	**6**
Skills	Knowledge and understanding For a passing grade the student must: • Know principal challenges of biobased industries • Know structure of principal biomass constituents, identify chemical functions of molecules, identify structural functions of molecules and supra-molecular assemblies • Implement and design an experimental approach concerning in appropriate sampling technologies, choice of proper experimental methods, analysis of results • Adapt existing experimental methods in the laboratory to the project problem • Know and follow security rules in a laboratory • Know legislative framework of bioindustries • Conduct a preliminary environmental impact assessment Competences and skills For a passing grade the student must: • Define project problem and context • Identify problem causes, propose working hypotheses • Evaluate results • Integrate results for different disciplines • Collect information, verify origin and diversity, integrate rules of intellectual property, realize a bibliography • Structure information using an academic formalism • Understand and adopt new concepts, knowledge and methods • Share knowledge and advance team work

	• Know and use basics of project management (work packages, project plan, resource allocation) Judgement and approach For a passing grade the student must: • Elaborate project definition and project plan and adapt it • Elaborate project presentation and report • Team work • Draw up a project assessment
Module Coordinator(s)	**Sandra** Domenek (AgroParisTech), **Sandrine Bouquillon** (URCA), **Aurore Richel** (ULiège), **Kontturi Eero** (Aalto), **Yevgen Karpichev** (TalTech)
Teaching staff	To be defined – depending on the project themes and locations.
Language of instruction	English
Nb hours of lectures	9
Nb hours of practical work	60
Nb hours of tutorials	21
Nb hours of personal work	48
Nb hours of other	6 (visit on industrial site)
Length of the internship in weeks	
Bibliography recommended	
Prerequisites	
Teaching period (when)	March - May
Place of teaching (where)	AgroParisTech or TalTech
Assessment	Project presentation and report by groups assessed by the corresponding supervisors and the module coordinators.