Course Descriptions for the Joint Study Programme
"International Master of Science in Engineering, Entrepreneurship and Resources (MSc. ENTER)

Version 07.2024

Courses at **Lappeenranta-Lahti University of Technology**
with the Specialization "**Chemical and Process Engineering**"

Module Name	**Current Issues in Enabling Technologies for Circular Economy**
Code	BJ02A1500
ECTS Credits	**5**
Responsible	Miia John, PhD
Institute(s)	LUT School of Engineering Science
Duration	4th period (3.3.2025 – 20.4.2025)
Teaching Language	English
Learning Outcome (Competencies)	By the end of the course, the students are expected to be able to: 1. Understand basic concepts of circular economy (raw materials, processing, manufacturing until end-of-life recycling and reuse) and the drivers for change from linear to circular economy. 2. Understand and evaluate the processing technologies of materials in context of circular economy. 3. Recognize and compare impacts (environmental, economic and social) of processing technologies when assessing the current (linear) practice of material processing vs circular value chains. 4. Apply the transferable skills of life cycle thinking (ecodesign) to evaluate processing technologies in circular value chains.
Contents	The course will introduce the most important processing technologies that enable the implementation of circular economy, such as recycling and recovery as well as separation and purification technologies. The approach of the course is mainly solution based and thus aims to show practical examples on the utilization of different technologies in solving different kind of challenges in circular economy. A special emphasis is laid on topical themes, such as recycling and upgrading of plastic, electric, packaging and textile waste as well as on the production of biofuels. The course will also introduce the concept of ecodesign as a tool to manage the complex value chains in circular economy.
Teaching Methods	Online tutorials 8 h, online discussions and peer feedback 27 h, Moodle exams, and weekly assignments 40 h. Project work 60 h.
Pre-requisites	Not mentioned
Assessment Methods	There is no exam on this course. The student group will prepare a short pitching video and a report on a specific subject. In the assessment peer and self-evaluation will be utilized. In addition, the course material includes compulsory or voluntary quizzes or questions related to the topic at hand. Project work 39 %, assignments 37 %, discussions in Moodle forum 24 %
Grading	Numerical assessment, scale 0-5

Materials/literature	Course material is available in Moodle and consists of video lectures and scientific and topical articles.
Workload	135 h
Note	Online teaching -The course is suitable for distance learning.

Module Name	**Knowledge Discovery and Process Data Analysis**
Code	BJ02A2000
ECTS Credits	**5**
Responsible	Satu-Pia Reinikainen, Prof., D.Sc. (Tech.) Tuomas Sihvonen, PhD
Institute(s)	LUT School of Engineering Science
Duration	4th period (3.3.2025 – 20.4.2025)
Teaching Language	English
Learning Outcome (Competencies)	By the end of the course, the student is expected to • be aware of the effect of digitalization and automation on amount, nature, and quality of data from chemical engineering point of view • have acquired a basic knowledge of the main concept of knowledge discovery process concerning industrial data • be able to apply specified methods and methodology on data • be able to apply management and cooperation skills in implementation of project work.
Contents	The knowledge discovery is referring to the overall process of discovering useful knowledge from data. The knowledge discovery process is interactive and iterative and involves several steps starting from studying the application domain and ending to use of the information discovered. Process data analysis can be part of this process. Fundamental concepts - such as reliability of data, preprocessing (e.g., de-noising, handling missing data, and scaling strategy), data reduction, choosing methodology, validation, modelling, etc - will be addressed in tutorials, Moodle assignments, and discussions. A project work will be carried out in small groups that will define their working methodology. The course is suitable for distance learning.
Teaching Methods	Online tutorials 7 h, online discussions and peer feedback 7 h, Moodle exams 7 h, and assignments 20 h. Project work 40 h, online independent study 49 h.
Pre-requisites	Basic skills in Matlab programming and mathematics.
Assessment Methods	Project work 39 %, assignments 37 %, discussions in Moodle forum 24 %.
Grading	Numerical assessment, scale 0-5
Materials/literature	Tutorial videos, online material distributed or announced in Moodle.
Pre-requisites	Basic skills in Matlab programming and mathematics.
Workload	130 h
Note	Online teaching -The course is suitable for distance learning.

Module Name	**Process Intensification**
Code	BJ02A2051
ECTS Credits	**5**
Responsible	Arto Laari, PhD
Institute(s)	LUT School of Engineering Science
Duration	4th period (3.3.2025 – 20.4.2025)

Teaching Language	English
Learning Outcome (Competencies)	Upon completion of the module, students will be able to: - Explain the principles and goals of process intensification, describe the advantages of process intensification and typical intensification methods. - Describe the principle and applications of intensified reactors and separation equipment, combination of reaction and separation, hybrid separation, alternative energy sources, and transformation of batch processes to continuous ones. - Recognize possibilities to intensify processes and apply intensification technology in existing processes. - Work in project teams, report and present project results.
Contents	The course covers different process intensification methods and their theoretical background. Teaching involves lectures, assignments, meetings and seminars. The main work will be carried out as a process design project assignment where students will work in teams aiming to intensify a process given by the teacher. Each team will write a report and present their results in seminar. The topics focus mainly on intensification of different Power-to-X processes, such as production of E-fuels, carbon neutral products, energy storage etc.
Teaching Methods	Lectures, meetings and seminars 28 h, 4th period. Team work, self-study, preparation for seminars and examination 107 h.
Pre-requisites	Not mentioned
Assessment Methods	Moodle examination 30%, project report and seminar 70%. Moodle examination must be passed with at least 50% from maximum points.
Grading	Numerical assessment, scale 0-5
Materials/literature	Video lectures, lecture notes and other material given by the teacher.
Workload	135 h
Note	Blended teaching.

Module Name	**Academic Entrepreneurship**
Code	CS34A0060
ECTS Credits	**6**
Responsible	Tuuli Ikäheimonen, PhD
Institute(s)	LUT School of Engineering Science
Duration	3rd and 4th period (6.1.2025 – 20.4.2025)
Learning Outcome (Competencies)	The course aims to develop the students' awareness of their entrepreneurial mindset. The aims also include enhancing the students' understanding of entrepreneurial opportunities and routes for grasping them. Furthermore, the students learn new ways to commercialize their knowledge, skills and research activities.
Contents	• The central concepts of entrepreneurship • The entrepreneurial mind-set, motivations, resources and opportunity recognition • The anatomy of the venturing process • Commercializing academic skills and research activities • Communicating entrepreneurial ventures
Teaching Methods	Lectures, individual and group assignments, possible exam, practicing presentations, study visits or visitor lecturers during the periods 3-4.

Pre-requisites	Not mentioned
Assessment Methods	course assignments and/or exam.
Grading	Numerical assessment, scale 0-5
Materials/literature	Shane, Scott (2003) A general theory of entrepreneurship. The individual-opportunity nexus. Edward Elgar. Other literature to be announced later.
Workload	162 h
Note	Blended Teaching. The course will be organized for 8-25 persons. The priority is given for students of Master's Programme in Engineering, Entrepreneurship and Resources (ENTER) and/ or Master's Programme in Entrepreneurship, Innovation, and Technology Integration in Mining project (MEITIM). The course is especially suitable for those students interested in developing their entrepreneurial competences and enhancing their employability skills.

Module Name	**Start-ups and venture formation**
Code	CS34A0780
ECTS Credits	**6**
Responsible	Noora Heino, PhD
Institute(s)	LUT School of Engineering Science
Duration	3^{rd} and 4^{th} period (23.1.2025–20.4.2025)
Learning Outcome (Competencies)	After the course the student is familiar with business start-up theories and processes, is able to critically analyze different business ventures and is skilled in testing business ideas and models. In addition, the student is able to analyze business cases and prepare a business plan with its calculations as well as pitch the plan successfully.
Contents	Entrepreneurship theory and process, business ideas and opportunities, business models, entrepreneurial teams, start-ups and spin-offs, start-up process and development stages, start-up strategies and sequencing activities, start-up financing, testing of business ideas, business plans, cases.
Teaching Methods	Online course, full digi. Individual assignments and preparing for Moodle exam, independent work 114h. Group work 48h.
Pre-requisites	Not mentioned
Assessment Methods	Individual assignments 60%, group work 30%, Moodle exam 10%
Grading	Numerical assessment, scale 0-5, evaluation 0-100 points
Materials/literature	Barringer, B.R. & Ireland, R.D. (2006 or later edition). Entrepreneurship: successfully launching new ventures. Pearson Prentice Hall. Other materials distributed during the course.
Workload	162 h
Note	Blended teaching. Max. 40 participants. Priority is given to the students of ENTER programme. In case that the course will not be organized due to too low number of participants, students who are completing an entrepreneurship minor may opt for one of the following courses: CS30A1665 Strategic entrepreneurship in the age of uncertainty or CS30A1342 Technology and Innovation Management, project course

Elective courses: Students choose at least 3 ECTS points (CP) from the elective course list.

Module Name	**Simulation, Laboratory Course**
Code	BK70A0102
ECTS Credits	**5**
Responsible	Aki, Mikkola, Prof.
Institute(s)	LUT School of Energy Systems
Duration	3rd and 4th period (6.1.2025–20.4.2025)
Teaching Language	English
Learning Outcome (Competencies)	The student will learn the advanced theories and practices of the mathematical modelling and computer simulation of machine systems. The student will be able to utilise advanced simulations to solve a practical design assignment. The student will be able to verify and evaluate the accuracy of simulation models. The student will be able to conduct individual scientific work to analyse the dynamics of machine systems.
Contents	Spatial kinematics, modelling of flexible bodies in multibody applications, modal reduction methods, real-time simulation, embedded systems, contact modelling, multibody dynamics on failure analysis, vehicle modelling, model verifications, practical measurements.
Teaching Methods	Completion method 1. Exam: Lectures 22 h, periods 3-4. Teamwork in a multi-cultural working environment 34 h, periods 3-4. Supervised tutorials 36 h, periods 3-4. Independent study 43 h, periods 3-4.
Pre-requisites	Recommended: Course BK70A0001 “Simulation of a mechatronic machine” completed.
Assessment Methods	examination 45 %, simulation work 45 %, in class quizzes 10 %
Grading	Numerical assessment, scale 0-5
Materials/literature	Lecture notes. Shabana, A. A.: Dynamics of Multibody Systems, Cambridge University Press, 3rd edition, 2005. ISBN 0-521-85011-8.
Workload	135 h
Note	Online teaching -The course is suitable for distance learning.

Module Name	**Advanced Course in Life Cycle Assessment**
Code	BH60A2102
ECTS Credits	**8**
Responsible	Olli Helppi Risto Soukka, Prof. Sanni Väisänen, Ass. Prof.
Institute(s)	LUT School of Energy Systems
Duration	3rd and 4th period (6.1.2025–20.4.2025)
Teaching Language	English
Learning Outcome (Competencies)	Upon completion of the course the student is expected to be able to 1. explain the basic life cycle concepts 2. plan, implement and analyse assessments to select products and services which fulfil the requirements of sustainable development 3. plan, implement and analyse assessments to reveal development needs of products and services

	4. recognise the most inexpensive ways to reduce the environmental impact 5. perform life cycle assessments using software 6. apply theories to find and develop the most sustainable product, process or system design.
Contents	Introduction to life cycle assessment (LCA), carrying out life cycle assessment, aspects related to inventory analysis, aspects related to impact assessment, calculating a carbon footprint, introduction to organizational LCA, introduction to life cycle costing, aspects related to life cycle costing, LCA, S-LCA and LCC examples. This course is also suitable for postgraduate students.
Teaching Methods	3rd period: 8 h of lectures, 2 h workshop, 12 h of computer training. Assignment 1 with a Quiz, learning diary, individual work and group work and seminar presentation (approx. 43 h). 4th period: 4 h of lectures, 12 h of computer training. Assignment 2 with Life cycle modelling task, final report and result presentation meeting, group work (approx. 89 h). Examination and preparation for it (approx. 40 h).
Pre-requisites	Recommended: BH60A6000 Basic Course in Life Cycle Assessment, BH60A2401 Energy Recovery from Solid Waste or BH60A0252 Solid Waste Management Technology or other course considering waste systems and BH20A0720 Engineering Thermodynamics or other course including the fundamentals of engineering thermodynamics.
Assessment Methods	Assignments 75 %, examination 25 %
Grading	Numerical assessment, scale 0-5
Materials/literature	Walter Klöpffer, Birgit Grahl Life Cycle Assessment (LCA), A Guide to Best Practice. Standards ISO 14040 and ISO 14044.
Workload	210 h
Note	Blended Teaching. Location: Lappeenranta, Lahti *In order to take the course, the student should have own laptop computer with Windows (limited number of computers in classroom available)*

Module Name	**Integration of Product's Design, Sustainable Production and Material Selection**
Code	BK50A3900
ECTS Credits	**5**
Responsible	Harri Eskelinen, Ass. Prof.
Institute(s)	LUT School of Energy Systems
Duration	3rd and 4th period (6.1.2025–20.4.2025)
Teaching Language	English
Learning Outcome (Competencies)	After having passed this course, the student will be able to: - apply systematic and analytical means for carrying out the DFMA-analysis of different types of components and assemblies and suggest improvements either to product design, material selection, manufacturing stages or production - utilize analytical tools to evaluate products' manufacturability and assembly aspects in industrial production and integrate these aspects with the results of functionality analysis of different product variants - take care of material related DFMA-viewpoints in the context of sustainability and sustainable development goals (SDG)

	- build an analytical overall model for integrating aspects of product design, sustainable production and environmental friendly material selection - utilize commercial manufacturability data from industrial workshops in DFMA-analysis - compare objectively different subcontractors for industrial production, e.g. for P2X applications
Contents	Different systematic and analytical means for carrying out the DFMA-analysis of different types of components and assemblies. Analytical tools to evaluate products' manufacturability and assembly aspects in industrial production and means to integrate these aspects with the results of functionality analysis of different product variants. Practical ways to recognize material related DFMA-viewpoints in the context of sustainability. Tools to build an analytical overall model for integrating aspects of product design, sustainable production and environmental friendly material selection. Means to utilize commercial manufacturability data from industrial workshops in DFMA-analysis and compare objectively different subcontractors for industrial production. During the project work industrial products will be reassembled and analyzed by utilizing presented DFMA-tools. Special viewpoints of sustainable development goals (SDG) and application areas of P2X.
Teaching Methods	Depending on your study program (face-to-face, Lab, JEDI, MEC or IDE) choose the right sub-page in Moodle. Introduction lecture 2 h, period 1, DFMA-analysis of product variants 55 h, project work including team discussions with the teacher, written report and video presentation 78 h, periods 1-4.
Pre-requisites	B.Sc.(Mech.Eng)
Assessment Methods	Comprehensive and continuous evaluation 50% and written report with a video presentation 50% (gemetric mean).
Grading	Numerical assessment, scale 0-5
Materials/literature	Lecture notes and DFMA-evaluation forms available in Moodle.
Workload	135 h
Note	Blended teaching. The course is mainly intended for visiting or exchange students.

Module Name	**Bioeconomy**
Code	BJ04A7010
ECTS Credits	**5**
Responsible	Ikenna Anugwom, PhD Mikko Rahtola
Institute(s)	LUT School of Engineering Systems
Duration	Summer – Summer (2.9.2024–31.7.2025)
Teaching Language	English
Learning Outcome (Competencies)	By the end of the course, the student is expected to have -gained the basic understanding of various perspectives of bioeconomy - gain updated knowledge of modern biorefineries and the basic prerequisites for operation and sustainable business - is able to apply the knowledge in creating a business canvas for a chosen case and according to instructions - is able to study to her/him previously unknown product- market or business cases

Contents	The study entities are: The multidimensional impact of bioeconomy on Europe, the implementation of bioeconomy, the sustainability – all three dimensions - aspects of bioeconomy. The course is carried as assignments based on selected topics from the book or own topic related to your current working environment and additional material. Course is planned for distance learning.
Teaching Methods	Individual studying and assigments based on the book. Moodle is used as the learning platform.
Pre-requisites	Not mentioned
Assessment Methods	Moodle assignments 100 %
Grading	Numerical assessment, scale 0-5
Materials/literature	Book: A Sustainable Bioeconomy The green industrial revolution by Professors Mika Sillanpää and Chaker Ncibi. Other related material announced later.
Workload	Not mentioned
Note	Blended teaching: Lappeenranta campus and Moodle

Module Name	**Development of New Sustainable Products and Solutions**
Code	BJ04A2010
ECTS Credits	**5**
Responsible	Rama Layek, Ass. Prof.
Institute(s)	LUT School of Engineering Systems
Duration	4^{th} period - summer (3.3.2025–31.5.2025)
Teaching Language	English
Learning Outcome (Competencies)	After completing the course, the students will be familiar with various types of new sustainable product development and solutions. • Student will get adequate knowledge for tailoring of functionalities of biobased polymers to meet functionality needed for specific the application. • Student will be familiar with various renewable resources (biomaterials, biochemiclas, cellulose, lignin, starch, carbohydrates etc) based sustainable product development and their applications • have an insight into material and molecular design and its role for the product performance • Use of forest resources and forest derived biomaterials for food, pharmaceuticals, composites, industry, and other applications.
Contents	The course contains an introduction with an overview of sustainable biobased product, bio-based barrier technologies for packaging applications, Biobased Hygienic Products and Solutions, Biomaterials for Printing, Biobased tall oil product. and Biomaterials in food application. Fundamentals about biomaterial design, modification, synthesis and use of fibers, cellulose (derivatives), lignin in various products. Chemical and mechanical modification, separation methods, mixing and drying methods. Product specification requirements and characterization methods. In addition, the course contains an interesting topic of group and individual assignment related to modern trends of sustainable biobased products and solutions.
Teaching Methods	Lectures (5X3=15 h), Exercises (20 h), topic-based group assignments (55 h) and individual assignments (45 h)

Pre-requisites	Not mentioned
Assessment Methods	Assessment: 0-5. Exercises (20%), group assignment/video presentation (50%) + individual assignment (30%)
Grading	Numerical assessment, scale 0-5
Materials/literature	Lecture material will be distributed via Moodle.
Workload	135 h
Note	Blended teaching.

Module Name	**Power-to-X processes**
Code	BJ02A6020
ECTS Credits	**5**
Responsible	Arto Laari, PhD
Institute(s)	LUT School of Engineering Systems
Duration	1st period – summer (2.9.2024–30.7.2025)
Teaching Language	English
Learning Outcome (Competencies)	Upon completion of the module students will have an overview of the current trends in chemical industry to replace fossil-based products with products manufactured from renewable electricity.
Contents	The course covers recent topics in chemical engineering related to energy transformation, including generation of renewable hydrogen, carbon capture and utilization, E-fuels, Power-to-X processes, and carbon neutral products and processes.
Teaching Methods	Lectures 28 h, self-study and assignments 107 h.
Pre-requisites	Not mentioned
Assessment Methods	Assessment: 0-5. Exercises (20%), group assignment/video presentation (50%) + individual assignment (30%)
Grading	Numerical assessment, scale 0-5
Materials/literature	Video lectures, lecture notes and other material given by the teacher
Workload	135 h
Note	Online teaching -The course is suitable for distance learning.

Module Name	**Fluid Dynamics in Chemical Engineering**
Code	BJ02A2030
ECTS Credits	**5**
Responsible	Tuomas Koiranen, Prof.
Institute(s)	LUT School of Engineering Systems
Duration	3rd period (6.1.2025–23.2.2025)
Teaching Language	English
Learning Outcome (Competencies)	Upon completion of the module students will have an overview of the current trends in chemical industry to replace fossil-based products with products manufactured from renewable electricity.
Contents	The course covers recent topics in chemical engineering related to energy transformation, including generation of renewable hydrogen, carbon capture and utilization, E-fuels, Power-to-X processes, and carbon neutral products and processes.

Teaching Methods	Exercise based lecturing 21 h (MS-TEAMS or class-room lecture), home exercises and quizzes 70 h (in Moodle). 3 homeworks (Lectures 1-3) will be about hands-on calculations (fluid mixing short-cut methods, engineering maths&calculations). 4 CFD exercises (Lectures 4-7), COMSOL Multiphysics. Project work and report 20 h, 3rd period. Self-study 44 h.
Pre-requisites	BH40A1400 Fluid Dynamics I or equivalent passed, BM20A1501 Numerical methods I or equivalent passed.
Assessment Methods	50 % homeworks, 25 % of the Quizzes (each weekly Quiz 0-100 %), 25 % of Project work.
Grading	Numerical assessment, scale 0-5 50 % of the grade is from homeworks (each homework grading 0-100 %), 25 % of the Quizzes (each weekly Quiz 0-100 %), 25 % of Project work. Overall grade for passing course should be at least 1.0.
Materials/literature	Lecture materials in Moodle. • Mixing Device Design • Perry's Chemical Engineers' Handbook, Perry, R.H., Green, D.W., Maloney J.O. (Eds.), McGraw-Hill, New York; Handbook of Industrial Mixing, Science and Practice, Paul, E.L., Atiemo-Obeng, V.A., Kresta, S.M., (Edits.), John Wiley & Sons, USA, 2004; EKATO-Handbook of Mixing Technology, EKATO Rühr- und Mischtechnik GmbH, Schopfheim; Zlokarnik, M., Stirring: Theory and Practice, Wiley-VCH, Weinheim, 2001 • CFD Material • Tu, J., Yeoh, G. H. & Liu, C. (2013). Computational fluid dynamics: A practical approach (2nd ed.). Amsterdam ; Boston: Elsevier/Butterworth-Heinemann (e-book); An introduction to computational Fluid Dynamics – The finite volume method, 2nd Edition, H. K. Versteeg and W. Malalasekera, 2007 • An introduction to computational Fluid Dynamics –The finite volume method, Second Edition, H. K. Versteeg and W. Malalasekera, 2007 (book) • Comsol Multiphysics User's Guide (inside Software) • www.cfd-online.com • www.bakker.org
Workload	135 h
Note	Contact teaching.