SOLID WASTE TECHNOLOGY AND RESOURCE RECOVERY – TEP4310
Raw Materials Exploration and Sustainability

CONTACT INFORMATION

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Course Webpage: https://www.ntnu.edu/studies/courses/TEP4310/2015#tab=omEmnet

COURSE CONTENT AND INTENDED LEARNING OUTCOMES (ILOs)

The course covers technologies for solid waste management and recycling and resource recovery from waste systems. The course is developed in collaboration with external partners from the waste management sector, as a result of a national project for increased priority to education and research within waste management and technology. There is a close collaboration with actors in the waste management sector, including Avfall Norge, waste companies, municipalities and other universities. The course has several guest lectures given by representatives from the waste handling sector, thus ensuring close contact and relevance of the course to the waste sector.

Knowledge
The student will obtain knowledge on:
- Strategies and solutions for solid waste management and recycling and resource recovery from waste systems;
- Theory regarding technologies for waste management and resource recovery from waste.

Skills
The student will be able to:
- explain the elements of waste policy;
- explain the main elements of waste generation and characterization;
- explain common technical solutions and designs for collection and treatment of waste and resource recovery from waste;
- interpret life cycle assessment studies of waste systems;
- reflect on important requirements for effective and environmentally friendly systems for solid waste.

General competence
The student will:
- be able to adopt a systems perspective in assessment of solutions and systems for solid waste management;
- be able to communicate in good ways with specialists and decision makers.

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Aligning with the EIT OLOs:

- ☑ EIT OLO 1 - Making value judgments and sustainability competencies
  2 - Highly relevant to the course content – The course trains the students in value judgements related to the role of waste management in a sustainable development by introducing them to new concepts and tools (lectures), by letting them apply these concepts and tools in different practical case studies (exercises and semester project), and through a poster presentation and extensive discussions in class.
- ☐ EIT OLO 2 - Entrepreneurship skills and competencies
- ☑ EIT OLO 3 - Creativity skills and competencies
  1 - Marginally relevant to the course – through the semester project the students are encouraged to investigate a relevant topic, and within this there is also room for the development of new ideas
- ☐ EIT OLO 4 - Innovation skills and competencies
- ☑ EIT OLO 5 - Research skills and competencies
  2 - Highly relevant to the course content – The course trains the students in developing research skills and competencies through the semester project, where the students work in interdisciplinary teams to investigate practical real-life problems related to waste management.
- ☑ EIT OLO 6 - Intellectual transforming skills and competencies
  1 - Marginally relevant to the course content – The course exposes the students to some extent to practical experiences through excursions and guest lectures by the waste industry representatives. These experiences are relevant for motivating the questions they are addressing in the exercises and for critically reflecting on the effectiveness of existing waste strategies in different contexts.
- ☐ EIT OLO 7 - Leadership skills and competencies

ASSESSMENT METHODS AND GRADING SYSTEM

Different assessment methods will be used to evaluate the students: content-based, competence-based and impact-based assessments. Content-based assessment refers to assessment tasks that mainly ask the learner about facts. Competence-based assessment refers to assessment of intended learning outcomes that ask the learner to show ability to also use these facts. Impact-based assessments take the assessment of competencies one step further and ask the learner to use these competencies in a real-life situation to create a change or solve a challenge. Active participation during the course is key to stimulate the students and allow them to reflect on topics related to waste management in a circular economy setting.

The course includes lectures, exercises and a semester project. The lectures equip the students with concepts and tools for approaching problems related to waste management in different contexts. The lectures have a strong focus on discussions and interactive learning. In the exercises and the semester project (which is conducted in multi-disciplinary teams), the students learn to apply these concepts and tools to different practical problems in the waste management sector, and to improve their skills in making value judgements related to the sustainability of alternative solutions (OLOs 1 and 5).

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The exam consists of two components: (i) a poster presentation of the practical case study conducted and (ii) an written examination. Both components test OLOs 1, and 5, however, the case study and poster presentation focus more on OLO5, while the written exam focuses more on OLO1. In the poster presentation, the students are asked to demonstrate how they have applied different research tools (including literature study, quantitative and qualitative research methods, work in cross-disciplinary teams) in order to identify and evaluate alternative solutions to specific problems (OLO5). The focus of the written exam lies on testing the students' ability to make critical value judgements related to different waste treatment alternatives. The students need to be able to critically reflect on consequences of alternative strategies and technologies in different contexts (OLO1).

ASSESSMENT METHOD	WEIGHT ON FINAL GRADE
Poster presentation	30%
Final Exam (written)	70%

COURSE SESSIONS

Reading materials: Selected parts of textbook: Thomas H. Christensen: "Solid Waste Technology & Management", Wiley 2011. Selected research publications and other materials will be available on Blackboard. Lecture notes are available on Blackboard the night before the lecture.

Session 1	**INTRODUCTION TO THE COURSE**
Content	• Introduction to the course • Outline of the contents and the assessment methods • Brief introduction to semester project work • Presentation of lecturers • Brief presentation of the textbook
Readings	-
Assignment	-

Session 2	**INTRODUCTION TO WASTE MANAGEMENT & ENGINEERING**
Content	• Introduction to waste management and waste engineering
Readings	Textbook chapters 1.1-1.2
Assignment	-

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Session 3	**WASTE ECONOMICS, POLICY AND LEGISLATION**
Content	• Waste economics • Waste policy • Waste legislation
Readings	Textbook chapters 1.3-1.4
Assignment	Exercise: Waste economics

Session 4	**WASTE GENERATION AND CHARACTERIZATION**
Content	• Waste generation • Waste characterization
Readings	Textbook chapters 2.1-2.5
Assignment	Exercise: Waste generation and composition

Session 5	**LCA OF WASTE MANAGEMENT SYSTEMS**
Content	• Basic principles of LCA • LCA in waste management
Readings	Textbook chapters 3.1-3.3
Assignment	Exercise: LCA

Session 6	**WASTE MINIMIZATION AND MATERIAL RECYCLING**
Content	• The waste hierarchy • Waste minimization principles • Material recycling principles
Readings	Textbook chapters 4.1-4.2, 5.1-5.5
Assignment	Field visit to the city's waste collection center

Session 7	**MECHANICAL WASTE TREATMENT**
Content	• Principles of mechanical waste treatment • Description of case from Trondheim The lecture is given by a guest lecturer from the municipality of Trondheim
Readings	Textbook chapters 6.1-6.4, 7.1-7.2
Assignment	Field visit to the city's waste collection center

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Session 8	**THERMAL WASTE TREATMENT**
Content	• Thermal waste treatment principles • Calorific value • Flue gas treatment • Description of different plants-case studies
Readings	Textbook chapters 8.1-8.8
Assignment	Exercise: Waste incineration Field visit to the city's waste incineration plant Guest lecture (from incineration plant)

Session 9	**BIOLOGICAL WASTE TREATMENT**
Content	• Composting • Anaerobic digestion • Operating parameters • End products
Readings	Textbook chapters 9.1-9.6
Assignment	Exercise: Biological waste treatment Guest lecture (from biogas plant or composting plant)

Session 10	**LANDFILLING**
Content	• Landfilling in the waste hierarchy • Regulations in EU and in Norway • Landfill build-up • Waster balance of landfills • Leachate quality • Landfill gasses – quality, collection
Readings	Textbook chapters 10.1-10.14
Assignment	Exercise: Landfilling

Session 11	**HAZARDOUS WASTE AND SPECIAL WASTE**
Content	• Hazardous waste characterization and handling • Producer responsibility • WEEE • Plastic and microplastic • Rare metals
Readings	Textbook chapters 11.1-11.5 + given readings

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Assignment	Guest lecturers from various companies

	STUDENTS SEMESTER PROJECT
Date - hours	During the semester, at assigned times, the students are working ingroups of 3, on a self-chosen topic related to waste or circular economy. Topics are to be approved by course responsible. There are several check-points, pitches, with feedback during the semester. At the end of the semester, the groups present their work through a short oral pitch and a poster presentation, where the rest of the class and the lecturers are audience.

	FINAL EXAM
Date - hours	The date and place of the poster presentation will be announced at the beginning of the course. The date of the written exam will be announced prior to the course start. The written exam lasts 4 hours.
Content	The exam will reflect the topics in the course curriculum, with a combination of facts, calculations, discussions and reflections on waste and circular economy issues.
Evaluation	The sum of the pitch and the poster contributes 30% to the total course grade. The written exam contributes 70% to the final grade.

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