

### Studieplan 2016/2017

### Master in Sustainable Manufacturing

**Studyprogramcode** MSUMA

#### Short description

The master study is focusing on the needs for increased knowledge on sustainable manufacturing: economic, ecologic and social sustainability for manufacturing processes and products throughout their lifecycle. The master will have an international focus but is based in the needs and co-operation with the regional industry. Guest –lectures are given by researchers, engineers and managers from the industry in the region complementing the academic teachers. Project works and master thesis are performed in industry. This close connection to the industry will enhance the understanding of the present challenges manufacturers are facing at the future expectations of needed competence. Each student will be offered an industrial or an academic mentor that will be an overall guide for the student.

The Norwegian Centre of Expertise (NCE) Raufoss is an expert centre for advanced light materials and automated manufacturing where NTNU in Gjøvik is a partner. This NCE form the basic industrial platform for the master. Selected partners in the NCE will be invited to form an industrial advisory board for the master. This board will give advices to the content and direction of the master education.

The student will receive the degree Master in Sustainable Manufacturing. The program qualifies the students to proceed to PhD studies.

The master study is suitable for candidates with a Bachelor's degree, who wish an education on sustainability in Manufacturing. Typical career possibilities can be as manager or engineers in manufacturing companies, building industry and similar. Suited background can be from engineering as well as industrial economy degree.

#### Duration

The Master will credit 120 ECTS credits and run full time over a period of 2 years, with an opening for extending this to 4 years for part-time students.

### Expected learning outcomes Knowledge:

The student finishing the master degree will possess advanced knowledge within sustainable manufacturing with the ability to contemplate impact from decisions on industrial economics, ecology and societal aspects on a holistic level. They will possess thorough academic knowledge within the field of manufacturing including lean leadership, total productive maintenance, product development, operations management etc. all in the overall context of sustainable manufacturing. They will be able to apply and utilize the knowledge within new areas and analyse previous unknown problems and challenges and plan and organize implementations of actions. Moreover the students will be able to evaluate and discuss results from the actions. The students can elaborate their knowledge in the direction of Knowledge management, Sustainable building production, Wireless industrial communication, Manufacturing Technology or Renewable Energy Technology dependent on the selected elective course and the content in the TØL4081 Project Work and TØL4901 Master Thesis.

#### Skills:

The students will be able to defend decisions with a foundation on mathematical and scientific terms and are able to distinguish between populist "green washing" and genuine steps towards sustainable manufacturing. The students are able to work independently with a systematic and scientific approach, as well as working in a team of colleagues and suppliers/customers. They can document and communicate impact on sustainability from their decisions and actions to colleagues, other experts as well as to the general public. They are able to use scientific databases and collaborate with universities and cutting edge experts within the field of sustainable manufacturing. They will have the skills for both an abstract birds-eye view and a detailed systematic approach to a problem or challenge. The students can utilize existing methods and tools for sustainability assessments, and adapt these to their own organization and local needs. The students are able to evaluate sources of information in a scientific way and structure and formulate professional and logical reasoning. The students will contribute to innovations and fresh thinking within the manufacturing industry contributing to the overall sustainability. The students will be able to re-think and change the applied methods according to changing demands and markets.

#### **General Competence:**

The students will through the master education develop knowledge, skills, ethics and behaviour promoting the move towards sustainable manufacturing of sustainable products. The students will be trained in individual work on an extensive level as well as work in a team. The students will be able to communicate and influence on colleagues, suppliers and customers and contribute to shape the basic values for future manufacturing. On the other hand will the student be able to have respect for divergent opinions and acknowledge. There is often a need for a multidisciplinary approach to reach a holistic improved solution.

#### **Target Group**

The primary target group of this education is national and international students with a technology, economics and/or management Bachelor's Degree, who are planning for a career in the manufacturing or building production industry. These students want to have an advanced understanding of how the dimensions on sustainability impact future management of manufacturing and building production and how economic, ecologic and societal aspects can be combined in a triple bottom line. The master education will also target students who seek an academic career with research within the field of sustainable manufacturing or related research fields.

The master programme should be suited both for candidates with working experience and young students directly from their bachelor degree. GUC wants to facilitate for good learning environment for the campus master students by offering a separate room for dialogue, discussions and study work. This will help our national and international students to develop close and inspiring relations, which we know is a positive factor to perform well. With flexible learning through Internet, both remote students and students taking the masters degree part time while they are continuing working are welcome. People with bachelor degree working in regional manufacturing industry will be an especially important target group, and the flexible teaching will be adapted to the need of the industry where problems and challenges form their own organization can be cases for the education.

Students entering the master programme should preferably have basic knowledge on statistical distributions and analysis, lean manufacturing, project management, organization and leadership, either from practical work life or from their pervious bachelor degree studies. For students with a 2-year

engineer education or similar; NTNU in Gjøvik will offer a 1 year pre-study to fulfill the requirements.

#### Admission Criteria

A student for the Master programme requires a Bachelor's degree according to the Norwegian framework for bachelor in engineering, bachelor in economics or equivalent. Applicants must have knowledge of English. For international students without a Bachelor degree from an English speaking university, a TOEFL test result of at least 600 points (computerized 250 points, on Internet 100 points) or IELTS test result of at least 6.0, including at least 6.5 is preferably.

#### **Course Structure**

The master programme will provide the students with a broad foundation for sustainable manufacturing. The programme will be based upon contemporary research in the field of Sustainable Manufacturing, as well as cases and examples from industry.

The master programme is interdisciplinary and consists of 8 courses, and TØL4081 Project work and TØL4901 Master Thesis. The courses at each semester will run either in parallel or sequential throughout the semester before ending in a final examination.

#### **SEMESTER 1:**

The first semester main focus is basic learning of Scientific methods and philosophy, Sustainable development, management and organizations theory. The semester contains the following basic courses:

- TØL4200 Scientific Methodology (5 ECTS)
- TØL4003 Philosophies of Social Science (5 ECTS)
- TØL4041 Sustainable Development (10 ECTS).
- TØL4021 Management and Leadership for Sustainability (10 ECTS)

TØL4200 Scientific Methodology will give the students knowledge about theory of science, research methodologies and how to plan, study literature, carry out searches in databases, handle research data and document work in a scientific way. The course TØL4003 Philosophies of Social Science will give the students knowledge about philosophies of social science which gives the students a basis for understanding social science research, choose research methods and how to interpret other researches philosophical standpoint. These two courses will be an important base for all following courses in the master in particular: TØL4051 Information Systems Strategy, TØL4081 Project work and the TØL4901 Master Thesis in 3rd and 4th semester.

TØL4041 Sustainable Development will give the basic introduction to sustainability. The understanding of the concept of sustainability with triple bottom line, remanufacturing and cross flow analysis are important parts of this course. The course gives the first introduction Life Cycle Assessment (LCA). This course is a basis for TØL4141 Sustainable Product development and Life Cycle Assessment in 2<sup>nd</sup> semester, as well as for TØL4061 Sustainable Manufacturing Systems and the elective courses in the 3rd semester.

TØL4021 Management and Leadership for Sustainability will give the students necessary basic knowledge on the Management, leadership and organizational development.

#### **SEMESTER 2:**

The 2nd semester focuses on quality, risk, sustainable development and Information Systems. The semester contains the two last basic courses:

- TØL4031 Quality and Risk Management (10 ECTS)
- TØL4151 Life Cycle Assessment (5 ECTS)
- TØL4161 Sustainable Products Innovations(5 ECTS)

This semester will also contain the first in-depth course:

• TØL4051 Information Systems Strategy (10 ECTS)

TØL4031 Quality and Risk Management builds on some of the topics from the course in early assessment of project, but will elaborate the learning outcome of statistical methods for quality and risk management. The Six-sigma paradigms, process variations, measuring systems assessment are new aspects in this course.

TØL4151 Life Cycle Assessment builds upon sustainable development and give the students more in-depth knowledge on LCA and practical experiences on using LCA tools. The understanding of how to use these tools and the limitations and possible misuse is important. The learning outcome of this course will be valuable for all following courses, in particular TØL4081 Project work and the TØL4901 Master Thesis in 3rd and 4th semester.

TØL4161 Sustainable Products Innovations will give the students necessary learning about products innovations and the process from idea stage, product development and implementation of the innovation.

TØL4051 Information Systems Strategy is the first in-depth course, and will give the student's knowledge and skills on how to implement and manage information systems including the increasingly important and numerous Information Technology (IT) within organisations and companies.

#### **SEMESTER 3:**

The previous two semesters have been mainly basic courses. In the 3rd semester, however, the students will continue on in-depth study of sustainable manufacturing. TØL4061 Sustainable Manufacturing Systems and TØL4081 Project work (both 10 ECTS) are required course for all students. The students should select one of the following elective courses for the last 10 ECTS:

- TØL4091 Sustainable Manufacturing Technolgy (10 ECTS)
- TØL4101 Wireless Industrial Communication (10 ECTS)
- TØL4111 Knowledge Management for Sustainability (10 ECTS)
- TØL4121 Renewable Energy Technology (10 ECTS)
- TØL4131 Sustainable Building Production (10 ECTS)

The selected elective course in combination with the selected content of TØL4081 Project work and TØL4901 Master Thesis in the 4<sup>th</sup> semester give a possibility to specialize within

The course TØL4061 Sustainable manufacturing system elaborates sustainable manufacturing on a systems level. Operations management, logistics material flow, value stream mapping and total productive maintenance (TPM) are important aspects of this course.

TØL4091 Sustainable Manufacturing Technology will make the students able to make choices on manufacturing technology, processes, operations and correct automation level in a manufacturing plant. The course will include automation, control engineering and robotics. Additive manufacturing, machining and automated assembly will be used as example processes.

TØL4101 Wireless Industrial Communication focus on wireless industrial automation capabilities, wireless signal transmission and receiving, and system design of different wireless industrial communication systems. The course covers the following topics: Wireless industrial automation, Baseband communication, Digital modulation/demodulation, Coding theory and Multiple Accesses. The students will be introduced to different wireless industrial communication systems: Wireless LAN, IEEE 802.15.4 and WirelessHART.

TØL4111 Knowledge Management for Sustainability will give an introduction to knowledge management. The course will cover topics as; the nature of knowing; intellectual capital and strategic management perspectives, creating knowledge, organizational learning and the learning organization, knowledge artefacts and give examples of tools for culture and management systems.

The elective course TØL4121 Renewable Energy Technology will introduce students to renewable energy resources availability, potential and deplorability as a substitute for conventional energy resources in future energy demand. The course will give introduction to conventional and renewable energy sources environmental impacts, challenges and future trends, fundamentals, potential, estimation and, applications. The following renewable energy sources are covered: Hydropower, Solar-, Wind-, Biomass-, Geothermal-, Tidal-, Osmotic- and Wave Energy

TØL4131 Sustainable Building Production will focus on energy-saving in buildings, Life Cycle Assessment of buildings, indoor air quality and health, monitoring tools for sustainable buildings and sustainable building processes. The students will learn about construction project planning (planning in practice, critical chain method, Gantt scheduling. They will be introduced to work flow and variation (theory of constraints and parade of trades), construction work flow and line of balance.

The basis for the TØL4081 Project work is more or less all of the other courses (except the thesis) since the project work should give the student a practical training on their total acquired knowledge within an industrial setting. The project work can be individual but is typically done as teamwork. The project work is normally a pre-project to the TØL4901 Master Thesis where the students will get training to work with a systematic scientific approach.

#### SEMESTER 4 :

The 4th semester is entirely dedicated to the TØL4901 Master Thesis. The thesis should preferably be conducted in collaboration with one or more companies, usually including the company where the student's mentor is located. There is a requirement that all 90 ECTS of the master program courses prior to the Master Thesis are passed before the TØL4901 Master Thesis can be approved. The Master Theses can be completed both in spring and in fall semester, dependent on the student progress. Flexible students on 50% might have the thesis running over 1 year.

#### Teaching methodes for the flexible master programme:

For both full time, part time and flexible students there will be an opening session at the start of the 1. semester. This will give the students guidelines and information about being a master student at NTNU

in Gjøvik, introduction to the relevant teaching methods, information about our expectations to a master student, and of course a good opportunity to meet with the teachers and fellow master students.

The on-campus students will follow normal lectures as well as group work, colloquiums/tutorials, and practical training. Real-life industrial cases will be utilized in the study. The teaching methods is based on blended learning with a combination of on-campus teaching as well as remote learning methods trough internet. As far as possible: the flex students and the campus students should be one group. Digital tools are used both for on- and off- campus students.

Thus, students and lecturers may be separated in space and time by using flexible learning methods, and communication and courses will partly or entirely be available for the student independent of place, space and time. Course material will be structured by means of a Learning Management System (LMS). Each course will have designated virtual classrooms in the LMS, and the LMS will be used for communicating all learning material, exercises, hand-ins and course administrative matters.

There will, however, be some mandatory seminars where all students must meet in person on campus.

Lectures will be made available by using different types of technology. Streaming, recording and publishing of campus lectures, pre-recording of shorter learning objects or use of web conferences technology are methods available. Some lectures will be offered in synchronous mode, while others may be asynchronous depending on the course's form and content. Collaboration is a well-acknowledged method for learning, and tools that will help distance students manage working together will be offered, for instance web conference tools.

Students and lecturers will be able to communicate through the Learning Management System or through live web conferences on line. Feedback to student work is an important part of student-lecturer communication. Tutoring will be emphasized; either one to one (student - lecturer) or one to many (group of students – lecturer), and this can also be executed in a synchronous or asynchronous manner. Tutoring will mainly be given on specific student work.

Some of the practical training, colloquiums and group work will, however, be performed with all students on campus (or in such a case within a industrial company). These face-to-face meeting periods will be coordinated among the courses at the same semester, in order to minimize the need for travel.

For the elective courses in 3<sup>rd</sup> semester, the pedagogical methods are adjusted to the number of students. If less than 4 students select the course, there education will be based on self-study to a large extent.

Examinations will as far as possible be home examination, to some extent combined with an oral exam. In some courses there might be written exam.

#### **Technical Prerequisites**

NTNU in Gjøvik will ensure that the students have access to the following technical requirements:

- Discrete event simulations software
- Life Cycle Assessment Software
- Manufacturing process laboratories
- The university library facilitates with computers for this purpose
- Availability of computers and necessary software

- Systems for internet bases education
- Workplaces and internet connection at the campus

There students need access to private computers.

The students will be given training in HES issues for laboratories and industrial environments, and access to necessary safety equipment such as protective glasses and shoes.

#### Internal/external examiner

The Master Thesis and the project work will have one internal and one external examiner. TØL4901 Master Thesis will in addition have one or two student opponents. The courses and the project work will have internal examiners, and external examiner every 4th year.

#### Internationalization

The courses will be conducted in English. The course teaching language is English. Teaching, tutoring, assignments and exam are given in English. This will ensure the possibility for international students to apply and collaboration with international universities to exchange students and research personnel. There will be invited lectures from international partners and exchange of students with international partners is welcomed. NTNU in Gjøvik will active promote students to study one semester abroad, on the condition that similar courses can be found on the collaboration university. This must be approved by NTNU in each separate case after an application from the students. An exchange in the last semester when the students are working on her/his thesis is a possibility, preferably in collaboration with the student's industrial mentor (for example where there is a collaboration university as well as a company manufacturing site close by).

**Publiser** Yes **Degree** Mastergrad

#### Master in Sustainable Manufacturing 2016-2018 Full time

Coursecode	Course name	C/E *)	ECTS each. semester				
			S1(A)	S2(S)	S3(A)	S4(S)	
TØL4200	Scientific Methodology	С	5				
TØL4003	Philosophies of social science	С	5				
TØL4041	Sustainable development	С	10				
TØL4021	Management and Leadership for Sustainability	С	10				
TØL4032	Quality Engineering	С		10			
TØL4161	Sustainable Products Innovations	С		5			
TØL4151	Life Cycle Assessment	С		5			
TØL4051	Information Systems Strategy	С		10			
TØL4061	Sustainable manufacturing systems	С			10		
TØL4081	Project Work	С			10		
	Elective course, 10 ECTS	Е			10		
TØL4902	Master Thesis	С				30	
		Sum:	30	30	30	30	

\*) C - Compulsory course, E - Elective course

### Master in Sustainable Manufacturing 2016-2020 - Recommended distribution of courses for a four year part time track

Coursecode	Course name	C/E *)	ECTS each. semester							
			S1(A)	S2(S)	S3(A)	S4(S)	S5(A)	S6(S)	S7(A)	S8(S)
TØL4200	Scientific Methodology	С	5							
TØL4021	Management and Leadership for Sustainability	С	10							
TØL4151	Life Cycle Assessment	С		5						
TØL4161	Sustainable Products Innovations	С		5						
TØL4003	Philosophies of social science	С	[		5		İ			
TØL4041	Sustainable development	С	i		10		İ			
TØL4032	Quality Engineering	С	i	İ	i	10	Í			
TØL4061	Sustainable manufacturing systems	С	i	İ	i	<u> </u>	10	ĺ		ĺ
TØL4051	Information Systems Strategy	С	[	ĺ	i	<u> </u>	İ	10		ĺ
TØL4081	Project Work	С	<u> </u>	ĺ	i	<u> </u>	ĺ	ĺ	10	
	Elective course, 10 ECTS	С				i			10	
TØL4902	Master Thesis	С				i				30
		Sum:	15	10	15	10	10	10	20	30

\*) C - Compulsory course, E - Elective course

#### **Electives (for full time and part time)**

Coursecode	Course name		ECTS each. se	ECTS each. semester		
			S1(A)	S2(S)		
TØL4101	Wireless Industrial Communication	E		10		
TØL4111	Knowledge Management for Sustainability	E		10		
TØL4121	Renewable Energy Technology	E		10		
TØL4131	Sustainable Building Process	E		10		
TØL4091	Sustainable Manufacturing Technolgy	E		10		
		S	um:	10		

\*) C - Compulsory course, E - Elective course



### Emneoversikt

### **TØL4xxx Scientific Methodology - Study plans 2016-2017**

**Course code:** TØL4200

**Course name:** Scientific Methodology

**Course level:** Master (syklus 2)

**ECTS Credits:** 5

**Duration:** Autumn

**Duration (additional text):** First half of autumn semester.

**Language of instruction:** English

Expected learning outcomes: *Knowledge* 

- have deep knowledge about central questions within the theory of science
- be able to analyze central topics within the theory of science
- know central terminology for scientific work
- Know channels and strategies for scientific communication

#### Skills

- be able to suggest a topic of investigation within science
- independently be able to make a plan of how to carry out a scientific work
- competence to search for academic publications using central databases
- facilitate and analyze data from science projects

#### General knowledge

- competence to read and analyze scientific publications
- be able to report results from scientific projects, including projects carried out by the student herself
- have developed a clear ethical attitude in relation to how scientific methodology is used

#### **Topic(s):**

- Introduction to the theory of science
- Characteristics of good research
- Research ethics
- Research as a means of systematic progress
- Quantitative and qualitative research designs
- Characteristics of good research topics and how to create one
- Literature studies
- Choice of methods, including planning and how to carry out and analyze experiments/studies
- Use of research databases for problem solving
- Data analysis and statistics

#### **Teaching Methods:**

Essay Lectures Group works Net Support Learning Project work

#### **Teaching Methods (additional text):**

The course will be offered both as an ordinary campus course and as a course that is offered in a flexible way to off-campus students. Lecture notes, e-lectures and other types of e-learning material will be offered through Fronter. Communication between the teachers and the students, and among the students, will be facilitated by Fronter.

The course will be made accessible for both campus and remote students. Every student is free to choose the pedagogic arrangement form that is best fitted for her/his own requirement. The lectures in the course will be given on campus and are open for both categories of students. All the lectures will also be available on Internet through GUC's learning management system (ClassFronter).

#### **Form(s) of Assessment:** Written exam, 3 hours

Grading Scale:

Alphabetical Scale, A(best) – F (fail)

**External/internal examiner:** External and internal examiner.

**Re-sit examination:** Ordinary re-sit examination in August.

Tillatte hjelpemidler:

**Examination support:** English dictionary.

#### **Coursework Requirements:** Essay

Participation in project work

Academic responsibility: Faculty of Technology, Economy and Management

**Course responsibility:** Studieprogramansvarlig

**Teaching Materials:** Books:

- Leedy, P D, and Ormrod, J E: "Practical Research, -Planning and design, 11th ed."Pearsopn Educational Int.
- Additional handouts and material made available on Fronter.

**Replacement course for:** IMT4421

**Publish:** Yes



### **TØL4003** Philosophies of social science - Study plans 2016-2017

**Course code:** TØL4003

**Course name:** Philosophies of social science

**Course level:** Master (syklus 2)

ECTS Credits: 5

**Duration:** Autumn

**Language of instruction:** English

**Expected learning outcomes:** After completing the course, the student is supposed to:

#### Knowledge

- have deep knowledge about central questions within philosophies of social science
- be able to analyze central topics within philosophies of social science

#### Skills

- be able to suggest a topic of investigation within qualitative research
- independently be able to make a plan of how to carry out a scientific work

#### General knowledge

- be able to report results from scientific projects, including projects carried out by the student herself
- have developed a clear ethical attitude in relation to how scientific methodology can be used to strive for a sustainable development of industry, the business world and society

#### **Topic(s):**

- Introduction to the philosophies of social science
- Paradigms and directions within social science
- Research ethics
- Research as a means of systematic progress
- Quantitative and qualitative research designs
- Characteristics of good research topics and how to create one
- Literature studies
- Choice of methods, including planning and how to carry out and analyze experiments/studies
- Use of research databases for problem solving
- Data analysis and statistics
- How to create a project plan
- Emerging focus on business ethics and the businesses' responsibilities with respect to the society
- Action-based research methodologies and philosophies

#### **Teaching Methods:**

Essay Lectures E-learning Project work Tutoring

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student are free to choose the pedagogic arrangement form that is best fitted for her/his own requirement.

The lectures in the course will be given on campus and are open for both categories of students. Lectures that sums up the main issues in the lecture will also be available on internet through GUC's learning management system (Fronter).

Tutoring are given at campus in accordance to announced times. In addition there will be at least on gathering at campus for remote students with mandatory laboratory exercises.

Tutoring is also available on internet.

**Form(s) of Assessment:** Other

**Form(s) of Assessment (additional text):** Final version of term paper.

**Grading Scale:** Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:**

Internal examiner. Additional external examiner every four years, next time 2017.

#### **Re-sit examination:**

New paper as re-sit exam.



#### **Tillatte hjelpemidler:**

**Coursework Requirements:** 2 Completed essays

Academic responsibility: Faculty of Technology, Economy and Management

Emneansvarlig kobling: Hans Christian German Johnsen

**Course responsibility:** Professor Hans Christian Garmann Johnsen

**Teaching Materials:** Arbnor, I. og B. Bjerke (2008) Methodology for Creating Business Knowledge . London: Sage

Additional literature, handed out or made available in Fronter.

**Replacement course for:** TØL4002

Publish: Yes



### **TØL4041 Sustainable development - Study plans 2016-2017**

**Course code:** TØL4041

**Course name:** Sustainable development

**Course level:** Master (syklus 2)

ECTS Credits: 10

**Duration:** Autumn

**Language of instruction:** English

**Expected learning outcomes:** After completing the course, the student is supposed to

#### **Knowledge:**

#### Course provides

- Advanced knowledge of sustainable development approach.
- Knowledge of sustainable practices.
- Knowledge of sustainability assessment.

#### Skills:

- Ability to identify problem areas in organization/city/country/etc. and possible solutions.
- Ability to identify an appropriate assessment method based on its pros and cons.

#### **General competence:**

- Integrate sustainability view into everyday decision-making
- Integrate sustainability aspects into long- and short-term planning
- Have understanding of the advantages of sustainable development approach and its challenges.
- Be able to apply sustainability into different sphere of influence (e.g. organization, community, city, country).

#### **Topic(s):**

- Globalization: positive and negative effect. Global problems (e.g. global warming, poverty, economic crises, deforestation, social stratification, etc.) and their interconnections.
- Sustainable Development approach (definitions, timeline, main documents, principles, actors and actions, challenges, critics).
- Examples of sustainable practices on the different levels (e.g. individual, community, organization, manufacturing, city, country, etc.)
- Sustainable development assessment on the different levels (e.g. product, process, organization, city, country, etc.)

#### **Teaching Methods:**

Other

#### **Teaching Methods (additional text):**

- Lectures
- Seminars
- E-learning
- Project work
- Group work
- Guest lectures

The course will be made accessible for both campus- and remote students. Every student is free to choose the pedagogic arrangement form that is best fitted for her/his own requirement.

The lectures in the course will be given on campus will be recorded and are open for both categories of students. Recordings of lectures, seminars and other learning activities will be available on internet through the learning management system. Tutoring are given at campus in accordance to announced times.

#### Form(s) of Assessment:

Other

#### Form(s) of Assessment (additional text):

- Group project work (60%).
- Written exam, 4 hours (40%).

#### **Grading Scale:**

Alphabetical Scale, A(best) – F (fail)

#### External/internal examiner:

Internal examiner. External examiner every 4 years, next time in 2018.

#### **Re-sit examination:**

Ordinary re-sit for the exam (next August).

For the project - new deadline for improved paper.

#### Tillatte hjelpemidler:

C: Spesifiserte trykte og håndskrevne hjelpemidler tillatt. Bestemt, enkel kalkulator tillatt.

#### **Examination support:**

English dictionary.

#### **Coursework Requirements:**

- Mandatory presence on the seminars for campus students. All students must attend 75% of seminars. Attendance trough the selected web meeting system is accepted.
- Hand-ins must be presented on the seminars all must be approved before exam.

The standard language is English. All hand-ins, exams etc. must be written in English.

#### Academic responsibility: Faculty of Technology, Economy and Management

#### **Course responsibility:** Professor Kristian Martinsen and PhD candidate Anastasiia Moldavska

**Teaching Materials:** Relevant articles and reports will be given at course start.

Publish:

Yes



### **TØL4021 Management and Leadership for Sustainability -Study plans 2016-2017**

**Course code:** TØL4021

**Course name:** Management and Leadership for Sustainability

**Course level:** Master (syklus 2)

ECTS Credits: 10

**Duration:** Autumn

**Language of instruction:** English

**Expected learning outcomes:** After completing the course, the student is supposed to

#### Knowledge

- Thorough knowledge of theory and practice in managing organizations
- Thorough knowledge of the role of sustainable leadership
- Thorough knowledge of basic concepts, principles and philosophy for Lean and learning organizations
- Thorough knowledge of the role of management and leadership in Lean
- Thorough knowledge of the importance of team work, participation and the Norwegian model in relation to Lean
- Reflect and plan for implementation effective and efficient organization with a sustainable and global perspective

#### Skills

• Develop managerial skills for future learning organizations

#### Competence

- Be aware of the history organizational and managerial theory
- Aware of the history of Lean development
- Understanding different managerial fads and fashions

#### **Topic(s):**

- History of organization and management theory
- Sustainable organization, management and leadership
- Managing individuals
- Managing teams and groups
- Leading, coaching and motivating
- Managing human resources and cultures
- Power, politics and decision-making
- Communication
- Knowledge and Learning
- Innovation and change
- Ethics and corporate social responsibility
- Philosophy of Lean, principles and culture
- Lean leadership, management and organization
- The Nordic/Norwegian model and Lean work organization and participation

#### **Teaching Methods:**

Lectures Group works

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student is free to choose the pedagogic arrangement form that is best fitted for her/his own requirement.

The lectures in the course will be given on campus and are open for both categories of students. Lectures that sum up the main issues in the lecture will also be available on internet through GUC's learning management system (Fronter).

Tutoring are given at campus in accordance to announced times. In addition there will be at least on gathering at campus for remote students with mandatory laboratory exercises.

Tutoring is also available on internet.

**Form(s) of Assessment:** Other

**Form(s) of Assessment (additional text):** Final version of term paper.

**Grading Scale:** Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:** Internal examiner. Additional external examiner every four years, next time 2019.

**Re-sit examination:** Continuation exam: New paper

#### Tillatte hjelpemidler:

#### **Coursework Requirements:**

Two individual works have to be presented both written and orally.

Academic responsibility: Faculty of Technology, Economy and Management

**Course responsibility:** Professor Tom Johnstad

**Teaching Materials:** Cole and Kelly (2011): Management Theory and Practice, Cengage Learning EMEA, 7th edition

Liker & Convis (2011). The Toyota Way to Lean Leadership. McGraw-Hill

Collection of articles available in Fronter

Publish: Yes



### **TØL4032** Quality Engineering - Study plans 2016-2017

**Course code:** TØL4032

**Course name:** Quality Engineering

**Course level:** Master (syklus 2)

ECTS Credits: 10

**Duration:** Vår

**Duration (additional text):** Spring

**Language of instruction:** English

**Expected learning outcomes:** After completing the course, the student will Knowledge:

• have a deeper understanding of the importance of statistical and probabilistic methods in the concurrent TQM culture.

Skills:

- be able to apply probability models and statistical tools to engineering problems.
- be able to apply design of experiments (DOE) to laboratory collected data using statistical tools

General Competence:

• Be able to grasp the possibilities and limitation of existing Quality Engineering tools for manufacturing processes and products

#### **Topic(s):**

- Evolution of Quality Design and Control
- Statistical Methods and Probability Concepts for Data Characterization
- Statistical Process Control
- Control Charts
- Planned Experimentation
- Design and Interpretation of 2k factorial experiments
- Lean manufacturing and Six Sigma
- Quality Management System and relevant international standards

#### **Teaching Methods:**

Lectures Group works E-learning Mandatory assignments Reflection

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student are free to choose the pedagogic arrangement form that are best fitted for her/his own requirement. Lectures that sums up the main issues in the lecture will also be available on internet through GUC's learning management system (Fronter). Tutoring are given at campus in accordance to announced times. Tutoring is also available via internet.

#### **Form(s) of Assessment:**

Home exam, see textarea

#### Form(s) of Assessment (additional text):

- Final Report
- Written individual report
- Individual oral exam (15 minutes) may adjust the grade up or down to the final grade.
- For off campus students the oral exam will be arranged through web conference.

#### **Grading Scale:**

Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:**

Internal examiners. External examiner every 4 years, next time 2020.

#### **Re-sit examination:**

Next ordinary exam -final report re-write and individual presentation.

#### Tillatte hjelpemidler:

#### **Coursework Requirements:**

- Individual assignments
- Students must pass 3 of 5 individual assessments to take final assessment

#### Academic responsibility:

Faculty of Technology, Economy and Management

**Course responsibility:** Assistant professor Rhythm Suren Wadhwa

#### **Teaching Materials:**

Course book reference available on Fronter Supplementary literature : see information in Fronter

#### **Replacement course for:**

TØL 4031 is replaced by TØL 4032



#### Publish:

Yes



### **TØL4161 Sustainable Products Innovations - Study plans** 2016-2017

**Course code:** TØL4161

**Course name:** Sustainable Products Innovations

**Course level:** Master (syklus 2)

ECTS Credits: 5

**Duration:** Vår

**Language of instruction:** English

**On the basis of:** TØL4041 Sustainable development

#### **Expected learning outcomes:** After completing the course, the student is supposed to have

#### KNOWLEDGE:

- advanced knowledge of product development in global value chains with focus on sustainability
- advanced knowledge of innovation processes in global value chains

#### SKILLS:

• ability to analyze and choose development methodology for sustainability in industry and market

#### GENERAL COMPETENCE:

- ability to evaluate scientific ethical implications of sustainable product development
- advanced understanding of innovation processes in general

#### **Topic(s):**

Product and process development:

- Product planning in an internal resource perspective
- Analyzing customer need
- Product specification
- Concept development and testing
- Prototyping and robustness
- Rights and economy
- Design for X

Design for sustainability

• Design for environmental sustainability (life cycle, minimal use of resources, life cycle optimizing and disassembly / recycling

• Methods and tools for environmental sustainability (life cycle analysis)

• Overview of research on sustainability

#### **Teaching Methods:**

Lectures Group works

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student are free to choose the pedagogic arrangement form that are best fitted for her/his own requirement.

The lectures in the course will be given on campus and are open for both categories of students. Lectures that sums up the main issues in the lecture will also be available on internet through the learning management system.

Tutoring are given at campus in accordance to announced times. In addition there will be at least on gathering at campus for remote students with mandatory laboratory exercises.

Tutoring is also available on internet.

**Form(s) of Assessment:** Written exam, 4 hours

**Grading Scale:** Alphabetical Scale, A(best) – F (fail)

**External/internal examiner:** 2 internal examiners

#### **Re-sit examination:**

If fail - revised project report can be submitted according to new deadline given by the course responsible.

Approved project essay/individual work is valid for 2 years

#### **Tillatte hjelpemidler:**

### **Coursework Requirements:** One individual work

Academic responsibility: Faculty of Technology, Economy and Management

**Emneansvarlig kobling:** Stig Roland Ottosson

**Course responsibility:** Professor Stig Roland Ottoson

#### **Teaching Materials:**

Stig Ottoson: Developing Sustainable Product Innovations (ISBN 978-91-639-1980-0)

**Publish:** Yes



### TØL4151 Life Cycle Assessment - Study plans 2016-2017

**Course code:** TØL4151

**Course name:** Life Cycle Assessment

**Course level:** Master (syklus 2)

ECTS Credits: 5

**Duration:** Vår

**Language of instruction:** English

**On the basis of:** TØL 4041 Sustainable Development

### **Expected learning outcomes:** After completing the course, the student is supposed to

#### Knowledge

- be able to define, execute and select methods and tools to assess sustainability performance of various concepts .
- knowledge of environmental indicators and their background

#### Skills

- ability to use appropriate evaluation or assessment methods to identify and analyze the sustainability performance of concepts
- ability to define and describe the object of assessment for different situations and systems
- ability to utilize and evaluate results from Life Cycle Assessment tools

#### **General competence**

- ability to evaluate scientific ethical implications
- understanding of sustainability performance in general

#### **Topic(s):**

Methods and tools for assessment of environmental sustainability (including life cycle analysis)

- Life Cycle Assessment (LCA) according to ISO 14040
- Characterisation, Classification and Normalisation
- Re-use and recycling
- Attributional and consequential LCA
- Use of tools as SimaPro
- Overview of research on sustainability

#### **Teaching Methods:**

Lectures Group works Tutoring

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student is free to choose the pedagogic arrangement from that is best fitted for her/his own requirement.

Seminars in the course will be given on campus and are open for both categories of students through web conferencing systems (Eluminate, Adobe Connect etc). Recordings of seminars and tutoring sessions will be available on internet through GUC's learning management system (Fronter).

#### Form(s) of Assessment:

Written exam, 3 hours Evaluation of Project(s)

**Form(s) of Assessment (additional text):** Written Exam: 40 %

Project work: 60 %

**Grading Scale:** Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:**

Internal examiners. Additional external examiner every four years.

#### **Re-sit examination:**

Revised project report can be submitted according to new deadline given by the course responsible.

Re-sit on written exam in August. Written exam can be altered to oral exam by the course responsible.

#### **Tillatte hjelpemidler:** B: Alle trykte og håndskrevne hjelpemidler tillatt. Bestemt, enkel kalkulator tillatt.

#### **Coursework Requirements:**

- Two hand-ins/assignments must be approved
- Mandatory presence on seminars

The standard language is English. All hand-ins, exams etc. must be written in English.

Academic responsibility: Faculty of Technology, Economy and Management

Emneansvarlig kobling: Guri Krigsvoll

**Course responsibility:** Associate professor Guri Krigsvoll

**Teaching Materials:** Compendium of articles/book chapters

Publish: Yes



### **TØL4051 Information Systems Strategy - Study plans 2016-2017**

**Course code:** TØL4051

**Course name:** Information Systems Strategy

**Course level:** Master (syklus 2)

ECTS Credits: 10

**Duration:** Vår

**Language of instruction:** English

**Expected learning outcomes:** After completing the course, the student is supposed to

#### **Knowledge:**

- Have advanced knowledge about the fundamentals and key aspects of strategic information management
- Understand the effects of Information systems strategy planning, development, implementation and validation

#### Skills :

- Communicate results and conclusions both oral and written with the discussion of knowledge and arguments which these are based on
- Plan and formulate Information System Strategy
- Manage, organize and structure development and maintenance of Information Systems
- Evaluate and suggest Information Systems regarding to organizational strategic goal and business benefits
- Identify and analyze key components in an organizations IT platform and Information Systems

#### **General competence:**

- Describe the role of Information Systems and IT Management have
- Understand how decisions about IT and management affects individuals, groups and organization

#### **Topic(s):**

- Conceptual developments in Information Systems Strategy
- Information Systems Stategic management (ISSM)
- Strategic Information Systems Planning (SISP)
- Information Strategy Models
- Information Technology Strategy
- Structure, culture and change management in information systems

#### **Teaching Methods:**

Other

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student is free to choose the pedagogic arrangement form that is best fitted for her/his own requirement.

The lectures in the course will be given on campus and are open for both categories of students. Lectures that sum up the main issues in the lecture will also be available on internet through NTNUs learning management system.

Tutoring are given at campus in accordance to announced times. In addition there will be at least on gathering at campus for remote students with mandatory exercises.

Tutoring is also available through internet.

The course teaching language is English. Teaching, tutoring, assignments and exam are given in English.

#### Form(s) of Assessment:

Other

#### **Form**(s) of Assessment (additional text):

Essay, value quality on final paper

#### Grading Scale:

Alphabetical Scale, A(best) – F (fail)

#### External/internal examiner:

Internal examiner. External examiner every 4 years, next time 2018.

**Re-sit examination:** New deadline for improved paper

#### Tillatte hjelpemidler:

#### **Coursework Requirements:**

- Completed at least 2/3 of assignments
- Participate in at least 50% of the tutorials and seminars



#### Academic responsibility: Faculty of Technology, Economy and Management

Emneansvarlig kobling: Kristian Martinsen

**Course responsibility:** Professor Kristian Martinsen

#### **Teaching Materials:**

Clarke, S (2007) Information System Strategic Management - An Integraget Approach. 2nd ed. Routledge.

Additional material available at GUC's learning management system (Fronter).

**Publish:** 

Yes



### TØL4061 Sustainable manufacturing systems - Study plans 2016-2017

**Course code:** TØL4061

**Course name:** Sustainable manufacturing systems

**Course level:** Master (syklus 2)

**ECTS Credits:** 10

**Duration:** Autumn

**Language of instruction:** English

#### On the basis of:

- TØL4041 Sustainable Development
- TØL4032 Quality and Risk Management
- TØL4051 Information Systems Strategy
- TØL4021 Management and Leadership for sustainability
- TØL4151 Life Cycle Assessment or TØL4161 Sustainable Products Innovation

#### **Expected learning outcomes:**

After completing the course, the student is supposed to have

#### **Knowledge:**

- knowledge about fundamental concept, strategies, principles and philosophy for sustainable processes and management
- knowledge about the importance of Total Productive Maintenance
- knowledge about Reverse logistics
- knowledge about Disassembly and remanufactuirng
- knowledge about Cleaner production

#### Skills:

- understanding of the impact of value chain for sustainable manufacturing understanding of the principles for Maintenance for Sustainable Manufacturing
- understanding of the needs for disassembly and remanufacturing

#### General kompetence:

- ability to use IT-tools for simulation of production, Discrete Event Simulation, with focus on calculations for sustainability
- ability to develop sustainable production processes
- ability to develop disassembly, remaufacturing and cleaning processes

#### **Topic(s):**

- Introduction to Operations management, Scheduling, capacity planning and production planning
- Total Productive Maintenance, Maintenance for Sustainable Manufacturing
- Plant Layout and material flow design and Discrete Event Simulations
- Supply chain design and management
- Sustainable Manufacturing Processes
- Recylability, reverse logistics
- Dissasembly and remanufacturing
- Cleaning technology
- Design for sustainable manufacturing

#### **Teaching Methods:**

Lectures Group works

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student is free to choose the pedagogic arrangement form that is best fitted for her/his own requirement.

The lectures in the course will be given on campus and are open for both categories of students. Lectures that sum up the main issues in the lecture will also be available on internet through the learning management system.

Tutoring is given at campus in accordance to announced times. In addition there will be at least one gathering at campus for remote students with mandatory laboratory exercises.

Tutoring is also available through internet.

All learning materials, lectures and tutoring will be in English. All hand-ins and exams must be in English.

**Form(s) of Assessment:** Other

#### Form(s) of Assessment (additional text):

• Report

**Grading Scale:** Pass/Failure

**External/internal examiner:** Internal examiners. External examiner every 4 years, next time 2019.

#### **Re-sit examination:**

For the oral exam there will be a re-sit in agreement with the course responsible.

#### **Tillatte hjelpemidler:**

C: Spesifiserte trykte og håndskrevne hjelpemidler tillatt. Bestemt, enkel kalkulator tillatt.

#### Examination support:

English dictionary, calculator

#### **Coursework Requirements:**

- 6 individual assignment works 4 must be approved
- Mandatory presence in seminars and exercises

#### Academic responsibility:

Faculty of Technology, Economy and Management

Emneansvarlig kobling: Kristian Martinsen

**Course responsibility:** Kristian Martinsen



**Teaching Materials:** Collection of articles from compendium

**Publish:** 

Yes



### TØL4081 Project Work - Study plans 2016-2017

**Course code:** TØL4081

**Course name:** Project Work

**Course level:** Master (syklus 2)

**ECTS Credits:** 10

**Duration:** Autumn and spring

**Language of instruction:** English

**On the basis of:** Pervious basic courses in the Master programme

### **Expected learning outcomes:** After completing the course, the student is supposed to

#### **Knowledge:**

• apply relevant tools and be able to find data to estimate parameters.

#### Skills:

- carry out an independent limited research and development projects.
- analyze the estimated parameters and assess the validity of the results.

#### General competence :

- communicate about technical issues, analysis and conclusions in the field, both with the company / organization and the public.
- contribute to innovation or improvements in the process.

#### **Topic**(s):

Students will carry out a project in corporation with a business or organization.

As part of the internship, students must write a report which has to meet the academic requirements at the master level.

The report shall be an academic work that must be related to current theory and practice, including the stay.



**Teaching Methods:** 

Other

#### **Teaching Methods (additional text):**

The course is based on students own work. It is open for cooperation among students, but individual final reports are mandatory. Tutoring of students will be made trough web conference-systems (Eluminate, Adobe Connect etc).

**Form(s) of Assessment:** Evaluation of Project(s)

**Form(s) of Assessment (additional text):** Project report

**Grading Scale:** Alphabetical Scale, A(best) – F (fail)

**External/internal examiner:** Internal and external examiner.

**Re-sit examination:** New improved report within 3 month

#### Tillatte hjelpemidler:

**Coursework Requirements:** Approved project plan and an oral presentation of the project report.

Academic responsibility: Faculty of Technology, Economy and Management

**Emneansvarlig kobling:** <u>Halvor Holtskog</u>

**Course responsibility:** Associate Professor Geir Ringen and Associate Professor Halvor Holtskog

Publish: Yes



### Elective course, 10 ECTS - Study plans 2016-2017

**Course name:** Elective course, 10 ECTS

**Course level:** Bachelor (syklus 1)

ECTS Credits: 10

**Duration:** Autumn and spring

**Language of instruction:** Norwegian

**Expected learning outcomes:** 

**Topic(s):** 

**Teaching Methods:** Group works

**Form(s) of Assessment:** Exercises

**Grading Scale:** Pass/Failure

#### Tillatte hjelpemidler:

Academic responsibility: Faculty of Technology, Economy and Management

**Course responsibility:** 

**Publish:** Yes

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### TØL4902 Master Thesis - Study plans 2016-2017

**Course code:** TØL4902

**Course name:** Master Thesis

**Course level:** Master (syklus 2)

**ECTS Credits:** 30

**Duration:** Autumn Vår

**Language of instruction:** English

#### **Prerequisite(s):**

All pervious courses (90 ECTS) of the Master program courses must be passed before the approval of the master thesis

#### **Expected learning outcomes:**

The thesis will demonstrate the student's ability to define and complete a science project with the aim to produce new knowledge. The thesis will demonstrate the student's ability to:

#### Knowledge:

- choose relevant methods according to the problem definition
- carry out the project according the chosen methods
- discuss the results and draw defensible conclusions and make recommendations

#### Skills:

- clearly and independently define a significant problem relevant to the master's program
- arrange necessary studies or experiments

#### General competence:

- Are capable of acquiring new knowledge
- Are capable of presenting scientific work and results in oral form

#### **Topic(s):**

- The student shall pick a specific problem of relevance to the Master's program.
- The topic must represent a challenge within the specific area and must require that the student adhere to practices that are common within the area.
- The topic must be preapproved by the supervisor.

#### **Teaching Methods:**

Other

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student is free to choose the pedagogic arrangement form that is best fitted for her/his own requirement.

The lectures in the course will be given on campus and are open for both categories of students. Lectures that sum up the main issues in the lecture will also be available on internet through GUC's learning management system (Fronter)

Tutoring are given at campus in accordance to announced times. In addition there will be at least on gathering at campus for remote students with mandatory laboratory exercises.

Tutoring is also available through internet.

#### Form(s) of Assessment:

Other

#### Form(s) of Assessment (additional text):

Project report and oral examination

- The project report is given a temporary grade.
- Individual oral examination (30 minutes) may adjust the grade up or down to the final grade, according to performance in the oral examination.
- Students must obtain a passing grade on the report to be able to present themselves for the oral examination.
- Students must pass both parts to pass the course
- For off campus students the oral exam will be arranged through web conference.

#### **Grading Scale:**

Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:**

The master thesis will have one internal and one external examiner.

#### **Re-sit examination:**

After failure (F), the student may submit a new or a revised thesis **once**. If the student chooses to submit a revised version of the thesis, this must be submitted in the following semester.

For the oral exam there may be a re-sit in agreement with the course responsible.

#### Tillatte hjelpemidler:

#### **Coursework Requirements:**

The student must participate in the supervision as a supervisee. The student must present a project status report to the supervisor within 3 months and demonstrate that the project can be completed according to the current project plan or, alternatively, adjust the plan accordingly to ensure a successful outcome. The status report must be approved by the supervisor. The student is required to defend the master thesis in an oral presentation with one fellow student as opponent. The student is required to review the work of one fellow student and to present this review during the student's defense.



#### Academic responsibility: Faculty of Technology, Economy and Management

**Emneansvarlig kobling:** <u>Stig Roland Ottosson</u>

**Course responsibility:** Professor Stig Roland Ottoson

#### Publish:

Yes



### **TØL4101** Wireless Industrial Communication - Study plans 2016-2017

**Course code:** TØL4101

**Course name:** Wireless Industrial Communication

**Course level:** Master (syklus 2)

ECTS Credits: 10

**Duration:** Autumn

**Duration (additional text):** Autumn 2016

**Language of instruction:** English

#### **Expected learning outcomes:**

After completing the course, students will have advanced knowledge on wireless industrial automation capabilities, wireless signal transmission and receiving, and system design of different wireless industrial communication systems.

#### **Knowledge:**

- Thorough knowledge on the different capabilities of wireless industrial automation for sustainability and strategy
- Advanced knowledge on methods for signal modulation and demodulation
- Advanced knowledge on methods for signal coding and decoding
- Thorough understanding of methods for multiple assesses
- Thorough understanding of the different industrial wireless communication systems

#### Skills:

- Can analyze existing methods for calculating with modulated signal
- Able to simulate modulated signal using computer simulation tools
- Can carry out an independent and limited research on system design of industrial wireless communication systems

#### **General competence**

- Understand the different wireless industrial automation capabilities
- Understand the different techniques for signal transmission and receiving
- Understand the system design of different wireless industrial communication systems
- Use computer tools to evaluate wireless industrial communication systems
- Can contribute to new thinking and innovation in the area of wireless industrial communication
- Can apply his/her knowledge and skills in new areas in order to carry out advanced assignments and projects within wireless industrial communication

#### **Topic(s):**

- Wireless industrial automation
- Baseband communication
- Digital modulation/demodulation
- Coding theory
- Multiple Accesses
- Introduction to different wireless industrial communication systems: Wireless LAN, IEEE 802.15.4, WirelessHART

#### **Teaching Methods:**

Lectures Group works

#### **Teaching Methods (additional text):**

The course teaching language is English. Teaching, tutoring, assignments and exam are given in in English.

The course will be made accessible for both campus- and remote students. Every student is free to choose the pedagogic arrangement which is best fitted for her/his own requirement.

Seminars in the course will be given on campus and are open for both category of students through web conference-systems (Eluminate, Adobe Connect etc). Recordings of seminars and tutoring sessions will be available on internet through GUC's learning management system (Fronter).

In case of less than 4 students, the course will be based on self-study.

#### Form(s) of Assessment:

Oral exam, individually

**Form(s) of Assessment (additional text):** Oral exam.

**Grading Scale:** Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:**

Internal examiners, external examiner every 4th year, next time 2017.

#### **Re-sit examination:**

For the oral exam there will be a re-sit in agreement with the course responsible.

#### **Tillatte hjelpemidler:**

**Examination support:** No support material allowed.

#### **Coursework Requirements:**

- 60% of hand-ins must be approved
- Mandatory presence on seminars and laboratory exercises

The standard language is English. All hand-ins, exams etc. must be written in English.

#### Academic responsibility:

Faculty of Technology, Economy and Management

**Course responsibility:** Michael Cheffena / Yun Ai



#### **Teaching Materials:**

Behrouz A Forouzan: "Data Communications and Networking", 5th Edition, 2013 IDC Technologies: "Industrial Wireless for Engineers and Technicians", 2008. Bogdan M. Wilamowski, J. David Irwin, Industrial Communication Systems (The Industrial Electronics Handbook), 2012.

Handout papers and reports

#### **Publish:**

Yes



### **TØL4111 Knowledge Management for Sustainability - Study** plans 2016-2017

**Course code:** TØL4111

**Course name:** Knowledge Management for Sustainability

**Course level:** Master (syklus 2)

**ECTS Credits:** 10

**Duration:** Autumn

**Duration (additional text):** The first time: autumn 2014

**Language of instruction:** English

#### On the basis of:

- TØL4021 Management and Leadership for Sustainability
- TØL4041 Sustainable Development
- TØL4051 Information Systems Strategy
- TØL4151 Life Cycle Assessment or TØL4161 Sustainable Products Innovation

#### **Expected learning outcomes:**

After completing the course, the student is supposed to have

#### **Knowledge:**

- Advanced understanding and insight into knowledge creation and learning processes
- Advanced understanding and insight into different paradigm of Knowledge Management
- Advanced understanding of the strategic importance of unique knowledge in building competitive advantages and innovation
- Advanced understanding and insight into the culture of knowledge creation and learning processes

#### Skills :

• Ability to use different paradigm of Knowledge Management for analyzing the process of knowledge creation in a company

#### **General competence:**

- Ability to understand Knowledge Management in a sustainable paradigm
- Ability to understand Knowledge creation process on a global scale

#### **Topic(s):**

- Introduction to Knowledge Management
- The Nature of knowing
- Intellectual capital and Strategic management peerspectives
- Creating knowledge; organizational learning and the learning organization
- Knowledge Artefacts; tools, culture and management systems
- Mobilising Knowledge
- Knowledge embedded in innovation

#### **Teaching Methods:**

Other

#### **Teaching Methods (additional text):**

Lectures and project work will be used to reach the targets for each attendant in the course. The course will be made accessible for both campus and remote students. Every student is free to choose the pedagogic arrangement form that fits for her/him.

The lectures will be given on campus and are open to both categories of students. Documentation that sums up the main issues of the lectures will also be available on the internet through the e-learning portal. Tutoring is given at the campus in accordance with announced schedules. In addition there will for remote students be at least one gathering at campus with mandatory attendance

In case of less than 4 students, the course will be based on self-study.

#### **Form(s) of Assessment:**

Other

#### Form(s) of Assessment (additional text):

- Final paper is given a temporary grade.
- Individual oral examination (15 minutes) may adjust the grade up or down to the final grade.
- Students must pass the final paper to be able to present themselves for the oral examination.
- Students must pass both parts to pass the course
- For off campus students the oral exam will be arranged through web conference.

#### **Grading Scale:**

Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:**

2 internal examiners. There will be an external examiner i 2018.

#### **Re-sit examination:**

Ordinary re-sit for the term paper (next August). For the oral exam there will be a re-sit in agreement with the course responsible.

#### **Tillatte hjelpemidler:**

C: Spesifiserte trykte og håndskrevne hjelpemidler tillatt. Bestemt, enkel kalkulator tillatt.

#### **Examination support:**

All available material

#### **Coursework Requirements:**

- 4 individual works 3 must be approved before the final exam.
- Mandatory presence on seminars

The standard language is English. All hand-ins, exams, etc must be written in English.

#### Academic responsibility:

Faculty of Technology, Economy and Management

### Emneansvarlig kobling:

Halvor Holtskog

#### **Course responsibility:** Professor Kristian Martinsen and Assistant Professor Halvor Holtskog

#### **Teaching Materials:**

Knowledge Management; an integrated approach, A. Jashapara, Second Edition, Financial Times/ Prentice Hall (2010), ISBN: 978-0273726852

Additional literature will be announced at the start of the course

#### Publish:

Yes



### **TØL4121 Renewable Energy Technology - Study plans** 2016-2017

**Course code:** TØL4121

**Course name:** Renewable Energy Technology

**Course level:** Master (syklus 2)

**ECTS Credits:** 10

**Duration:** Autumn

**Duration (additional text):** The first time: autumn 2014

**Language of instruction:** English

#### On the basis of:

- TØL4041 Sustainable Development
- TØL4151 Life Cycle Assessment or TØL4161 Sustainable Products Innovation

#### **Expected learning outcomes:**

Having completed the courses, the student should have

#### **Knowledge:**

The main purpose of this course is to introduce students with renewable energy resources availability, potential and deplorability as a substitute for conventional energy resources in future energy demand.

- Advanced knowledge about different renewable energy resources
- Thorough understanding on issues relevant to energy efficiency and energy storage.
- Advanced knowledge about potential of using renewable energy technologies as a complement to and to the extent possible, replacement for conventional technologies, and possibilities to combining renewable and non-renewable energy technologies in hybrid systems.
- Knowledge about strategies for enhancing the use of renewable energy resources for future demand.

#### Skills:

- Analysis on importance of renewable energy solutions for sustainable development
- Able to identify sustainable energy solutions for sustainable development
- Able to carry out techno-economic assessment
- Determination and analyzing emission in conventional energy systems

#### **General competence:**

- Develop competency in identifying renewable energy resources availability and utilization.
- Develop competency in rating different renewable energy technologies
- Students demonstrate competency in renewable systems analysis, independently.

#### **Topic(s):**

Introduction to conventional and Renewable energy sources environmental impacts, challenges and future trends, fundamentals, potential, estimation and, applications:

- Solar Energy
- Wind Energy
- Hydropower
- Biomass
- Geothermal Energy
- Ocean Energy

#### **Teaching Methods:**

Lectures Exercises Project work

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student is free to choose the pedagogic arrangement form that is best fitted for her/his own requirement.

The lectures in the course will be given on campus and are open for both categories of students. Lectures that sum up the main issues in the lecture will also be available on internet through GUC's learning management system (Fronter).

Tutoring are given at campus in accordance to announced times. Tutoring is also available through internet.

In case of less than 4 students, the course will be based on self-study.

#### **Form(s) of Assessment:**

Written exam, 4 hours Evaluation of Project(s)

#### Form(s) of Assessment (additional text):

written exam (counts 70%)

project assignment (counts 30%)

both must be passed

**Grading Scale:** Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:**

Two internal examiners. Additional external examiner every four years. Next time 2018.

#### **Re-sit examination:**

Ordinary re-sit for the written exam (next August).

For project - new deadline for submission of project assignment

#### **Tillatte hjelpemidler:**

**Coursework Requirements:** 50 % of hand-ins must be approved

Academic responsibility: Faculty of Technology, Economy and Management

**Course responsibility:** professor Alemayehu Gebremedhin

**Teaching Materials:** Will be given at course start

Publish: Yes



### **TØL4131 Sustainable Building Process - Study plans 2016-2017**

**Course code:** TØL4131

**Course name:** Sustainable Building Process

**Course level:** Master (syklus 2)

ECTS Credits: 10

**Duration:** Autumn

**Duration (additional text):** 3<sup>rd</sup> semester

The first time: autumn 2014

**Language of instruction:** English

#### On the basis of:

- TØL4021 Management for Sustainability
- TØL4031 Quality and Risk Management
- TØL4041 Sustainable Development
- TØL4151 Life Cycle Assessment
- TØL4161 Sustainable Products Innovations

#### Expected learning outcomes: Knowledge:

- Advanced knowledge on procurement for sustainable built environment.
- Advanced knowledge on life cycle energy and embodied energy of built environment and how to minimize the life cycle energy and embodied energy.
- Advanced knowledge on material selection and construction-site waste management.
- Advanced knowledge on how to map, design and manage work in construction so as to ensure a sustainable construction process.

#### Skills:

- Supply procurement solutions for sustainable built environment.
- Understand the role of embodied energy in built environment.
- Find solutions to minimize the life cycle energy of buildings.
- Select right material for sustainable construction.
- Planning of sustainable building production .

#### General competence:

- Present key points of your work to colleagues both in writing and orally.
- Speak the professional language of construction managers.

#### **Topic(s):**

- Procurement for sustainable built environment.
- Embodied energy and emissions of buildings.
- Selection of materials
- Waste management in construction
- Planning of sustainable building production.

#### **Teaching Methods:**

Lectures Group works Meeting(s)/Seminar(s) Tutoring

#### **Teaching Methods (additional text):**

The course will be made accessible for both campus- and remote students. Every student is free to choose the pedagogic arrangement from that is best fitted for her/his own requirement. Seminars in the course will be given on campus and are open for both categories of students through web conference-systems (Eluminate, Adobe Connect etc). Recordings of seminars and tutoring sessions will be available on internet through the learning management system.

Teaching language is English. All hand-ins, reports and examination must be delivered in English.

#### **Form(s) of Assessment:**

Written exam, 3 hours Evaluation of Project(s)

#### Form(s) of Assessment (additional text):

Written Exam: 40 %

Project work: 60 %

**Grading Scale:** Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:** Internal examiners. External examiner every 4 years, next time 2016.

#### **Re-sit examination:**

Revised project report can be submitted according to new deadline given by the course responsible.

Re-sit on written exam in August. Written exam can be altered to oral exam by the course responsible.

#### Tillatte hjelpemidler:

**Examination support:** All materials available

#### **Coursework Requirements:**

- Participation in Seminars
- Two hand-ins

#### Academic responsibility: Faculty of Technology, Economy and Management

**Course responsibility:** Associate Professor Guri Krigsvoll

#### **Teaching Materials:**

Compendium of articles and book chapter

#### Publish:

Yes



### **TØL4091 Sustainable Manufacturing Technolgy - Study plans** 2016-2017

**Course code:** TØL4091

**Course name:** Sustainable Manufacturing Technolgy

**Course level:** Master (syklus 2)

**ECTS Credits:** 10

**Duration:** Autumn

**Language of instruction:** English

#### **Expected learning outcomes:**

After the course, the students are supposed to have advanced knowledge and overview about sustainable manufacturing technology. The students shall be able to make choices on technology and manufacturing processes in a manufacturing plant. The course will include process automation for sustainable manufacturing, control engineering and robotics. Additive manufacturing, machining and automated assembly will be used as example processes. The students shall be able to decide operation planning paths and correct automation level.

#### Knowledge:

- Advanced knowledge and overview about sustainable manufacturing technology.
- Introduction to control engineering and theories of control systems used in automation
- Advanced knowledge on the role of automation and industrial robots in modern manufacturing
- Knowledge on process and operation planning
- Introduction to machining, additive manufacturing and automated assembly
- Knowledge about Labview and simulation tools for manufacturing processes

#### Skills:

- Can make choices on technology and manufacturing processes in a manufacturing plant
- Can carry out development and research on manufacturing technology

#### **General competence:**

- Understand the basics of sustainable manufacturing technology including theories of control systems and automation
- Can contribute to new thinking and innovation in the area of sustainable manufacturing technologies
- Can apply his/her knowledge and skills in new areas in order to carry out advanced assignments and projects

#### **Topic(s):**

- Overview on sustainable manufacturing technology.
- Process automation for sustainable manufacturing
- Introduction to industrial robotics, industrial automation and control engineering
- Additive manufacturing, machining and automated assembly
- Process and operation planning

#### **Teaching Methods:**

Lectures Laboratory work Exercises

#### **Teaching Methods (additional text):**

The course teaching language is English. Teaching, tutoring, assignments and exam are given in English.

The course will be made accessible for both campus- and remote students. Seminars in the course will be given on campus and are open for both categories of students through web conference-systems (Eluminate, Adobe Connect etc). Recordings of seminars and tutoring sessions will be available on internet through the learning management system. Laboratory exercises must be done on-campus.

In case of less than 4 students, the course will be based on self-study.

#### **Form(s) of Assessment:**

Home exam, 12 hours Oral exam, individually

#### Form(s) of Assessment (additional text):

- 12 hour individual home exam is given a temporary grade.
- Individual oral examination (15 minutes) may adjust the grade up or down to the final grade.
- Students must pass the home exam to be able to present themselves for the oral examination.
- Students must pass both parts to pass the course
- For off campus students the oral exam will be arranged through web conference.

#### **Grading Scale:**

Alphabetical Scale, A(best) – F (fail)

#### **External/internal examiner:**

Internal examiners. External examiner every 4 years, next time in 2016.

#### **Re-sit examination:**

Ordinary re-sit for the home exam (next August). For the oral exam there will be a re-sit in agreement with the course responsible.

#### Tillatte hjelpemidler:

#### **Coursework Requirements:**

- 60% of hand-ins must be approved
- Mandatory presence on seminars and laboratory exercises

The standard language is English. All hand-ins, exams etc. must be written in English.

#### Academic responsibility:

Faculty of Technology, Economy and Management

#### Emneansvarlig kobling: Kristian Martinsen

#### **Course responsibility:** Kristian Martinsen



#### **Teaching Materials:**

Selected compendiums given at the start of the course

#### **Publish:**

Yes