Description of all MIND courses (Erasmus Mundus Master's Programme in Industrial Ecology)

Waseda University Tokyo

Shinichiro NAKAMURA: Industrial Ecology, Course, 4 ECTS
This course is aimed at making students familiar with hybrid tools of IE; input-output analysis, environmentally extended input-output analysis, and waste input-output analysis. Topics to be covered include hybrid LCA, hybrid MFA (WIO-MFA), hybrid LCC, and their applications. Text: Waste Input-Output Analysis, S. Nakamura and Y Kondo, Springer 2009.

Shuji OWADA: Introduction to resource recycling engineering, Course, 4 ECTS
This course is to provide students with holistic knowledge in the area of resource-recycling engineering, involving how the recycling contributes to prolonging resource life and environmental harmonization. After having introduced the worldwide present status of resource and environmental problems and the Japanese legal frameworks that are relevant for resource recycling and environment, main features of resource recycling- and processing technologies are outlined together with major areas of their application.

S NAKAMURA, Y KONDO, K MATSUBAE, K NAKAJIMA: Workshop on IE, Seminar, 2 ECTS
This workshop deals with the newest developments in the areas related to hybrid approaches to IE.
An active involvement of students is expected.

Kenichi AKAO: Environmental Economics, Course, 4 ECTS
This course is aimed at making students familiar with standard knowledge of environmental economics and resource economics. Particular emphasis will be placed on the issues of scarcity and their relevance to sustainable economic growth. Text book: Scarcity and Growth Revisited - Natural Resources and the Environment in the New Millennium (Resources for the Future, 2005) R. David Simpson, Michael A. Toman, Robert U. Ayres.

Yukiko FUKAGAWA: Development Economics, Course, 4 ECTS
Economists have paid greatest attention to the shortage of capital or technology per se for many years, and have discussed how they should be allocated, but borrowing has become easier in recent days through the various risk management techniques and soaring direct investment by multi-national firms. Then, how to mobilize the resource including these "borrowed" ones effectively for the sustainable growth, has become one of the most important concerns, while mitigating the risk usually unexpected from the backlash of globalization. This is why achieving "good governance" has become the primary agenda for the development. In line with this change, this course explores why the "good governance" is needed in what context in each development stage, and will discuss what can make the governance better, mainly based on the experience by East Asia. Taking the outward oriented development strategies, the region has been fully integrated into the global economy, and has received most big economic shocks intensively from outside, which is expected to imply a lot for the followers, including late developing countries.

Shunji MATSUOKA: Environmental Economics and Environmental Policy, Course, 4 ECTS
This course will take a comprehensive look at environmental economics and environmental policy, from the history of its development to its application to current global issues. Particular emphasis will be placed on 3 types of environmental policy; command and control (CAC), market based instruments (MBIs), and voluntary approach (VA). Furthermore, policy evaluation theory and methodology will be discussed.
Key Words: Environmental Economics, Environmental Policy, Cost Benefit Analysis, Benefit Assessment, Project Evaluation, Policy Evaluation, Evaluation Theory.

K TAMAKI: Financial Engineering, Course, 4 ECTS
This course is to make students familiar with the techniques of time series analysis that are relevant for the analysis of economic and financial data. The first part of the course deals with basic models of time series analysis and GARCH models. The second part will be concerned with the application of time series techniques to financial engineering. Key words: arbitrage price theory, Black-Sholes equations, and portfolio.

Shunji MATSUOKA: Sustainable Development and International Development Cooperation, Course, 4 ECTS
This course will take a comprehensive look at the sustainable development, from the history of environmental problems to the application of sustainable development to international development and cooperation. Particular emphasis will be placed on using social capacity development approach as a base to examine the relationship between development and environment in the developing countries. Furthermore, this course will be focused on evaluation theory and environmental economics for analyzing and evaluating policies, programs, and projects for sustainable development. This course consists of 4 parts; introduction, development problems and development policies, development aid and cooperation, social capacity development, and evaluation theory.

Sum Waseda third semester: 30 ECTS

Fourth semester: Master Thesis, 30 ECTS

Asian Institute of Technology (Thailand)

Gender, Technology and Development, 2.5 ECTS
What is gender; gender as an organizing ideology in knowledge construction; history of technology and development in the Asian region

Natural resources management issues in Asia, 2.5 ECTS
This course will introduce students from various countries to the general natural resources management issues throughout the Asian region, with a focus on Thailand. Lectures will provide a regional perspective of contemporary natural resource management issues, and will be supplemented with one field trip in Thailand to view these issues first hand.
Structure:
I. Introduction to Natural Resources Management
II. Regional overview of environmental and natural resource issues
1. Natural resources base
2. Land use change
III. Key Issues in Natural Resources Management of Asia
1. Land Degradation and Conservation
2. Climate change and natural resources in Asia
3. Biodiversity and climate change in Asia
4. Coastal zone management and conservation
IV. Natural Resource Management Policies: case example of decentralization and policy outcomes of Asian forest governance and management

Rural and regional development, 7.5 ECTS
The course deals with the concepts of growth, development, under-development and anti-development, expectations and achievements in development planning, poverty analysis and poverty alleviation, changing approaches to rural development, international development co-operation, the spatial framework for regional development.
Course Outline:
I. Growth, Development, under-development and Anti-development
   1. Growth, Development and under-development
   2. Development Theories
   3. Development and disparities: Income, Rural-urban and Regional
   4. Anti-development
II. Expectations and Achievements in Development Planning
   1. Failure to achieve structural transformation of the economy, continuing predominance of the rural sector, despite (r) urbanization
   2. Continuing and increasing poverty amidst impressive growth achievements
   3. Search for explanations: Conventional, dualism, dependency, terms of trade and their implications, power structure at national and sub-national levels; core-periphery and rural-urban relationships
III. Poverty analysis and Poverty Alleviation
   1. Definition and measurement
   2. Different faces of poverty: Income and non-income poverty, famine, chronic poverty
   3. Poverty eradication/alleviation strategies and management: The basic needs, micro-finance, Sustainable Livelihood Approach, well being.
4. Experience of poverty alleviation programmes and policies in Asia
IV. Changing Approaches to Rural Development
   1. The sectoral Approaches: Agricultural development and land-reform, development of rural infrastructure, development of education and health, Integrated Rural Development; Decentralization and participation: Top-down and bottom-up planning
   2. Decentralization and participation: Top-down and bottom-up planning
   3. The Right-based Approach to Development
V. International Development Co-operation
   1. The Role of Aid in development
   2. The role of donors in development: Multilateral (The World Bank (PRSP), UNDP (MDG), bilateral and other donor agencies
   3. The policies of the donors: sectors, countries, regions within countries, ethnic groups within the countries.
VI. The Non-state Actors in Development: NGOs, civil society and New social Movement
VII. The Spatial Framework for Regional Development
   1. Brief introduction to the location theories: Agricultural location, Industrial location, Central Places
   2. Rural-regional development
   3. Growth centre theories and their implications
   4. Rural and regional development trends in developing Asia.

Rational Use of Energy in Buildings, 7.5 ECTS The building sector accounts for 30-40% of world's primary energy consumption and is responsible for about 33% of total global CO_2 emission. Buildings also provide the highest economic GHG mitigation potential. This course is intended to introduce essential and practical understanding of energy processes and rational use of energy in buildings. The course covers the external and internal energy processes involved in the control of the built environment. It also examines emerging technologies, policies and measures, to lower the building sector's dependence on fossil energies and enhance the integration of renewable energy.

Society and Natural Resource Management, 7.5 ECTS
Rationale: Natural resource managers are faced with a wide range of issues and responsibilities they must effectively address. Most of such issues have a social component. It is therefore important for the natural resource planners and managers to have an understanding of social dimensions of the complex natural resource issues so that they can take consideration of these factors in planning and implementation of projects related to natural resources management. Catalog Description: This course explores the relationship between society and natural resources. Emphasis is on social and institutional dimensions of common pool natural resources management. Some of the specific topics to be covered include contribution of sociology to the study of natural resources, changing paradigms and theories, political economy of natural resources management, collective action and the commons, community-based resource management, co-management, property rights and institutions governing the use and maintenance of the resource. This will be a reading and writing intensive course.

Health, Development and Environment, 5 ECTS
Human development and environment; environmental economy; natural resources management and land reformation; policy for public participation; application of economic incentives; appropriates laws and legislation; cleaner production technologies such as eco-design and green productivity.

Principles of Cleaner Production, 5 ECTS
Cleaner production audit; pollution prevention; mass and energy balance, energy and environmental audit, energy reduction; small and medium scale industries, process integration, design for environment, pinch analysis, occupational health and safety.

Sum AIT third semester: 37.5 ECTS (30 ECTS to be taken)

Fourth semester: Master Thesis, 30 ECTS

Rochester Institute of Technology (USA)

Core courses

Fundamentals of Sustainability Science, 4 ECTS
This course, taught by Callie Babbitt, introduces graduate students in the Sustainability program to the fundamental skills and concepts required to conduct original research related to the interaction of industrial and environmental systems. Students will understand the scientific method as it applies in a transdisciplinary approach to sustainability, gain an introductory understanding of the scientific disciplines of sustainability and systems thinking, and be prepared to identify original research problems, hypotheses and investigative methods.

Industrial Ecology, 4 ECTS
This course is taught by Callie Babbitt and is focused on the study of the human-induced transformation of materials and energy and linkages between industrial and natural ecosystems. The primary emphasis on this course is the demonstration and application of industrial ecology tools (material flow analysis, life cycle assessment, systems modeling) to fundamental research questions in sustainability. Students are engaged in project-based learning approaches that link the classroom principles with each student's specific research focus.

Economics of Sustainability, 4 ECTS
This course, taught by extended GIS program faculty Jeff Wagner and Amit Batabyal, explores how problems of sustainability arise within consumer theory and within the theory of the firm and can be analyzed using the neoclassical economics paradigm. Standard modeling tools used in economics are introduced. Environmental and resource economic policy instruments—taxes, tradable pollution permits, liability and regulation—are evaluated for use in various contexts in which sustainability is of concern. Consideration is given to how the economic theory of sustainability complements perspectives from other disciplines. The course concludes with a discussion of current issues in sustainability such as climate change.

Technology, Policy, and Sustainability, 4 ECTS
This course, taught by the Department of Science, Technology, and Science, introduces students to public policy as a multidisciplinary field for understanding how policy and regulation can be used to balance tradeoffs of social, environmental and economic goals. A key purpose of this course is to translate the notion of sustainability into practical goals and strategies. The course places particular emphasis on the policy process, the relationship among technology, policy, the environment and policy mechanisms for addressing market and government failures that threaten sustainability.

Understanding Risk from Multiple Sustainability Perspectives, 4 ECTS

This course taught by Gabrielle Gaustad examines the three pillars of sustainability (economy, environment, society) from a risk analytic perspective and presents an introduction to financial, toxicological and socio-political risk perspectives, management and communication. Topics include a review of probability, net present value, and discount rates, as well as estimation bias, formative scenario analysis and environmental health and safety perspectives on risk (dose response, exposure maximums, fate at end-of-life, leachants, emissions, etc.). Examples of readings include how to operationalize risk for use in sustainability studies (Valiela, Tomasky et al. 2008), integrating risk assessment with climate change (Schipper and Pelling 2006), and the emerging importance of sustainability risk management (Anderson 2006). Students complete problem sets on risk assessment, characterization, and management.

Multi-criteria Sustainable Systems Analysis, 4 ECTS

This course, taught by Gabrielle Gaustad, introduces and applies methods in systems analysis and multi-criteria decision making in the context of sustainable production systems. Topics include linear programming, value of information, constrained optimization, marginal analysis, utility theory, simulation, and uncertainty analysis. Example readings include sustainable energy planning (Pohekar and Ramachandran 2004), quantifying human values (Thøgersen and Ölander 2002), and forest management (Turner, Chikumbo et al. 2002). Illustrative examples from problem sets include network optimization (how to optimally collect waste), multi-criteria decision analysis (how to optimize profit while minimizing environmental impact), and blending problems (maximize use of secondary sources in metals batch planning). A final project charges students to formulate and program a multi-criteria problem dealing with their research foci. Examples include maximizing resource recovery for hybrid vehicles by managing life-cycle mismatch of the battery with the car, and optimizing the photovoltaics development portfolio conflicting criteria of efficiency, cost, and decreased environmental impact.

Elective Courses

Climate Change Science and Solutions, 4 ECTS

As today's students move into climate action leadership roles in industry, business, research, and teaching, they must be equipped with a fundamental understanding of climate change science, an appreciation for the widespread environmental, social, and health impacts of global warming, and an ability to innovate and critically analyze climate change mitigation strategies. This course will provide a broad overview of climate change science and impacts, as well as an introduction to creating and evaluating technological, social, policy, or economic solutions for climate change mitigation. The course will incorporate lectures, discussions, readings from primary and secondary literature, carbon footprint exercises, and papers or projects that examine the many facets of potential carbon neutral strategies. Instructor is Callie Babbitt

Sustainable Product Design, 4 ECTS

This course integrates sustainability factors with traditional product design methods. Lectures and projects incorporate strategies such as effective sustainability methods and life-cycle assessment; enhancement of product value and prolonged use; and balance between recycling, reusing and repurposing. Sustainable Product Design enables an interdisciplinary collaboration between Sustainability and Industrial Design. Both areas will offer their unique approach while learning and integrating knowledge from each other. This course is co-taught by Callie Babbitt and Alex Lobos (ID).

Applied Life Cycle Assessment, 4 ECTS

Life cycle assessment (LCA) is a tool used in the field of industrial ecology to evaluate the environmental impacts of products or processes over their entire life cycle – from raw material extraction, manufacturing, use, and end-of-life management. This course will build on fundamental principles of LCA by allowing students to conduct project-based studies on the application of LCA to real-world sustainability issues. Students will apply process, economic input-output, and hybrid methodologies to evaluate technological systems for opportunities of environmental improvement. Learning outcomes include (1) ability to apply LCA in a realistic project setting; (2) understanding of major methodological challenges associated with conducting LCA; (3) proficiency in the use and understanding of the limitations of common LCA software; and (4) ability to prepare a peer-reviewed publication in the field of LCA. Taught by Callie Babbitt

Materials Cycling – Closing the Loop, 4 ECTS

This class will explore the economic and environmental incentives for recycling and resource recovery. The focus will be on end-of-life fate of materials (including plastics, metals, glass, and e-waste) while setting these within the context of overall ecosystem flows (carbon, sulfur, and nitrogen cycles, waste water, etc.). Technologies for the upgrading of secondary material streams will be studied including: physical and physico-chemical (beneficiation, electrostatic and magnetic separation), hydrometallurgical (selective precipitation, leaching, ion exchange), biotechnological (biosorption, sulfate reduction), and pyrometallurgical (filtration and fluxing). Production issues (product quality, remelt thermodynamics, exergy accounting, etc.) within the secondary industry will be explored with an emphasis on removing barriers to increased usage of scrap. Efforts for enhanced collection efforts and motivation of consumer and firm participation will also be covered (municipal collection fees, corporate take-back initiatives, legislation such as the WEEE directive, state deposits, etc.) Instructor for this course is Gabrielle Gaustad.

Sum RIT 3rd semester: 24 ECTS core courses and 16 ECTS electives (30 ECTS to be taken)

Fourth semester: Master Thesis, 30 ECTS

University of Graz

First study year

Tartiu, Propst: Modelling of Systems, lecture, 3 ECTS
Modelling human-environment systems, socio-technical systems, etc. Review of the major paradigms/ models. Introduction to: (i) systems dynamics models, (ii) multi-agent models, (iii) Markov processes, (iv) Monte Carlo simulation and their applicability for different problems embedded in the sustainability framework.
Introduction to spatially distributed mathematical models with PDEs (partial differential equations, reaction-advection-diffusion); introduction to simulations with such models; introduction to climate modelling.

Kirchengast: Earth's Climate system and Climate Change, lecture, 3 ECTS

The Earth climate system (basic terminology, components, phenomenology, balance principle); paleoclimate and history of climate; climate observation, types of elements, climate classification; physical climate mechanisms and geo-biochemical cycles; climate modeling and prediction; anthropogenic climate change, global warming and change; climate change and economy. Dependent on level of knowledge and foci of interest of participants some room exists to account for this in weighting the depth of treatment of the different sub-topics above.

Füllsack: Integration and evaluation of systems, lecture, 3 ECTS

The course covers basics of applied work with systems analysis and systems modeling.

Students will be able to assess the possibilities and preconditions of systems analysis and modeling. Additionally, they will be familiar with the most common methods of data mining and data analysis and with possibilities to consider empirical data in modeling.

Füllsack, Schmickl: Seminar on systems modeling, 4 ECTS
In this seminar the students will get an overview of the theoretical ecology and the basic types of ecological interactions, students create models by using "VenSim" and explore the ecological problem "Mono See". This seminar shows, what happen when a person affects a stable existing habitat and changes it and how the civilization influences the global homeostatic process and how such interventions lead to irreversible consequences.

Füllsack, Huber: Seminar on systems integration and assessment, 4 ECTS
In this course the students will get an introduction into System Dynamics modeling, including the history of systems science, common behavior of systems, causal loop diagrams and stock-flow diagrams. Students will learn to use the program "VenSim", analyze, build, and simulate simple System Dynamics models. After this course students are able to write a paper and peer-review a paper of colleagues, present and discuss their findings with them.

Aschemann: Introduction to Industrial Ecology, seminar, 4 ECTS
The seminar presents an overview of "Industrial Ecology". It will address its definition(s), ideology and principles, history and future directions, Moreover, its areas of application and main technical terms, methods and tools will be discussed, such as material flow accounting; substance flow analysis; life cycle assessment; footprint approaches; industrial metabolism.

Aschemann: Environmental and technology assessment, Course, 4 ECTS
The course "Environmental and Technology Assessment" focuses on key assessment tools regarding the environmental context with particular emphasis on their possibilities in terms of application and advancement.
Students should be able to understand the concept and the application range of methods and tools such as environmental impact assessment (EIA), strategic environmental assessment (SEA), technology assessment (TA), sustainability impact assessment (SIA), health impact assessment (HIA) and life cycle analysis (LCA), both in theory and in practice. Moreover, they should know strengths and weaknesses of the tools mentioned in order to get the ability to select the suitable tool for the problem given and to define its proper framework requirements. Finally, they should be aware of actual research issues regarding those instruments and the opportunities for their advancement and further development.

Gelbmann and Schmidt: Waste and Recycling, Course, 4 ECTS
Waste management is a task that has to be accomplished by enterprises, both by those who produce waste and those who see to it. This course provides for both sides: giving an overview of different kinds of (solid) wastes that may accrue and the ways firms can deal with them, the legal bases that have to be accounted for (like devising corporate waste management concepts or the regulations on packaging). If an enterprises devises proper strategies of waste separation and disposal, this can add to both, environmental protection and enterprise efficienc

Zimmermann, Fischer, Wlasak: Selected topics in sustainable tourism, Lecture/s and/or seminar/s, 8 ECTS
Topics cover political, social, ecological and economic developments, underpinned with detailed research questions which lead to an integrated approach to the overall topic of the seminar.

Kenik, Steiner: Sustainability entrepreneurship, Course, 4 ECTS
In this course the students will get an overview of the standards, tools and methods for eco-controlling, especially for analyzing ecological opportunities and threats for the firm, the strengths and weaknesses within the company, as well as for planning, controlling, and reporting on the eco-performance of the organization. After this course students are able to reflect the challenges and basics of eco-controlling, are able to understand the concepts of strategic and operational eco-controlling and are able to apply instruments for eco-controlling.

Globocnik: Product and Service development, Course, 4 ECTS
The course distinguishes between the creating of incremental product innovations and breakthrough product developments (radical product innovations). Based on case studies of new products and specific group projects, students will learn about basic state of the art approaches for product developments including the appropriate methodologies. Hereby, stakeholder analysis plays a crucial role for the investigation of the given preference profiles of existing and potential customer groups as well. Further, by focusing on the so called "fuzzy front end" students learn to deal with ill-defined markets and needs and to identify future opportunities by applying future oriented techniques such as the scenario technique and rapid prototyping. Strategic thoughts on how to transform those opportunities into sustainable marketable products are consequently also part of this course.

Baumgartner, Engert, Rauter: Eco-Controlling, Course, 4 ECTS
In this course students will get an overview of the standards, tools and methods for eco-controlling, especially for analyzing ecological opportunities and threats for the firm, the strengths and weaknesses within the company, as well as for planning, controlling, and reporting on the eco-performance of the organisation. Here, methods like eco-balances, material flow analysis, environmental cost accounting and different approaches for environmental oriented evaluation will be discussed. Environmental/sustainability performance measurement will also be content of the course.

Gelbmann: Strategic Sustainability Management, Course, 4 ECTS
Content of this course is corporate social responsibility. After this course students are able to understand the basics of strategic sustainability management, are able to develop, implement, and control concepts for strategic sustainability management and are able to devise and implement sustainability reports and other communications of sustainability performance reporting.

Aschemann: Value Chain Management, Course, 4 ECTS
In this course, essential basic concepts and principles of value chain management (VCM) will be taught, focusing on its relations to industrial ecology. In order to deepen the students' VCM understanding, some case studies will be discussed, too. The students shall be able to understand, to classify and to apply the essential concepts and principles of VCM.

Perstel: Selected Topics of Sustainability and Innovation Management, Course, 4 ECTS
The increasing intensification in technology as well as the quest for economic growth throughout a wide range of industries has resulted in a strategic management and product development problem when looking at the middle- and long term, safe and continuous supply perspectives of raw materials. Solutions according to the European Union are reduction, substitutions and a cascading use of materials in various products. In this course you will discover a range of materials from around the world and their influence on design and economic developments. Some materials are coming from unexpected sources, including scallop shells, currency, mobile phones, airplane windscreens and natural fibers.
When focusing on reduction it is essential to understand some parts of a modern design process and recognize that up to 90% of the materials that we throw away are recoverable.
Eco-Design methods and understanding about a variety of materials will essentially lead to a more holistic sustainability-view in regards to raw materials in a mid- and long term perspective.

Electives
6 ECTS have to be chosen from the entire courses offer of the university (e.g. the MIND summer school between first and second study year is worth 3 ECTS; internships can be done as well, maximal 6 ECTS, equivalent to four weeks full-time employment).

Sum Graz first study year: 60 ECTS

Second study year

Dully, Perstel: Integrated Management Systems, Course, 4 ECTS
The objective of the course lies in the switching of basic knowledge in management systems (including environmental management, quality management, systems for occupational health and safety, etc.) and in the training of management methods and instruments for the implementation of an integrated management system. A specific focus will be on

environmental aspects of such management systems. Furthermore, important aspects of the common management standards (ISO 14001, EMAS, ISO 9001, OHSAS 18001 ...) are presented and discussed. Finally students should apply their acquired knowledge on different case studies.

Rauter, Perl-Vorbach: Sustainable Innovation, Course, 4 ECTS
The course aims at building up a systematic understanding of sustainable innovation processes which goes beyond particular product, service or process innovations. Sustainable innovations also require social, cultural or institutional innovations – in other words: system innovations – to create viable alternatives to existing structures and products and to be able to unleash their sustainability potential. Promoting more sustainable forms of production and consumption requires strategies at different levels: at the level of firms for creating more sustainable products and services, at the level of policy to create conditions for innovation systems for sustainability, and at the level of civil society to develop new practices of use and consumption and to articulate demand in a qualified way.

Brudermann: Environmental Decision-Making, Course, 4 ECTS
This course addresses decision making in an environmental context. The course will provide an introduction to current topics in environmental psychology and critical discussions of relevant insights from behavioural economics, economic psychology, neuro-economics and game theory.

Colombino: Spaces of Consumption, seminar, 4 ECTS
The seminar is aimed at discussing with the students some of the main key-concepts in human geography, with a specific focus on contemporary geographies of production and consumption.
The seminar will concentrate on the main topics treated in the book:
Mansvelt, Juliana (2005) "Geographies of Consumption", Sage, London, pp. 190. (Please see below for a list of topics). The students are required to read this book before the seminar starts (beginning of December 2013).
Another important resource for the seminar is the website "Follow the Thing" http://www.followthethings.com/ (curated by Ian Cook, Department of Geography, University of Exeter, UK), which will be used to explore the multiple social, economic and cultural geographies that 'lie behind' the production and consumption of a variety of commodities such as our mobile phones, the food we put on our plate, our clothes, etc.
Facebook Page: www.facebook.com/pages/followthethingscom/132471660166786
Twitter account: www.twitter.com/followthething

Colombino, Ermann, Roelofsen: Urban and Regional Development, seminar, 4 ECTS
The Urban and Regional Development seminar will host 3 international geographers who will deliver lectures on current urban development trends and politics, tourism and local and regional development, brands, branding and territorial development. This year's guest speakers are:

1. Andy Pike (University of Newcastle)
   http://www.ncl.ac.uk/curds/people/profile/andy.pike
2. Alberto Vanolo (University of Turin)
   http://www.campusnet.unito.it/docenti/att/avanolo.cv.pdf
3. Claudio Minca (University of Wageningen)
   https://www.wageningenur.nl/en/Persons/prof.-C-Claudio-Minca.htm

Crockett, Posch, Winkler: Inter- and Transdisciplinary Case Study on Sustainable Development, Tutorial/Project work, 10 ECTS
In the course we will work on a specific case study concerning energy and sustainable lifestyle. In order to understand different connections the students will work in small groups on specific sub-topics. We will see the interdisciplinary linkages between topics and problems concerning global issues such as resource use, urbanisation, energy efficiency, etc. on a smaller, local scale. Concepts of (personal) energy usage will be discusses as well as topics of sustainability in general.

Aschemann, Mayer, Meyer; Aschemann, Baumgartner, Perstel, Ulz, Zettl: Interdisciplinary practical training, Tutorial/Project work, 10 ECTS
The topic of the course is changing every semester. A maximum of 20 students will work together with a team of lecturers during the whole semester on a specific issue. For study year 2014/15, the following two topics are offered:

(a) In order to maintain the current services of the NPO MEGAPHON, it is necessary to work cost-efficient. Therefore it is important that vendors of the journal find optimal selling conditions at all points of sale in Styria. In the IP the best POS will be identified and additionally suggestions fora tool will be developed, which enables the administration of the POS in practice.
Two working groups will cover the following areas:
Spatial organization: Analysis of the pedestrians flows in selected Styrian cities, Regional criteria: Identification of the optimal regional distribution of vendors (areas, points-of-sale, on-the-fly sale), Optimization of routes of the vendors, Recommendations for system-oriented management tools
Economic organization: Social and legal criteria, Criteria for sales organization, Identification of the most important sales areas, Development of a ranking procedure (waiting list, vendor – point of sale), Identification of the most suitable form of organization.

(b) Students should deal with a sustainable design of offices, focusing on its environmental component. Through the involvement of four units of the university, the acquired knowledge can be applied to the students' environment. Furthermore, the students will present their findings and recommendations in a guidance, dealing with the sub-topics "green building", "green interior", "green IT" and "green behaviour". Those sectors of an environmentally optimized office design enable the involvement of all focus areas of environmental systems sciences. Moreover, the results from the correspondent IP organized in summer term 2014 will be considered and used. The overall research question is: "How can the concept of "green office" be applied and optimized for the University of Graz?"

Sum Graz third semester: 30 ECTS

Fourth semester: Master Thesis, 28 ECTS plus Master Examination, 2 ECTS (Sum: 30 ECTS)

Leiden University, Delft University of Technology

First study year

G. Korevaar: General Introduction to Industrial Ecology, Course, 6 ECTS
This course gives an overview of the status quo in the field of Industrial Ecology. It also gives an overview of the sustainability contents of the Master Program Industrial Ecology. The students are introduced to the concepts of the technosphere-biosphere analogy, the principles of life-cycle thinking, eco-design, stakeholder investigation, and organizational aspects of industrial clustering. The interdisciplinary and problem-oriented character of the field is presented in an industrial assignment. Study goals are:
- overview of the field of Industrial Ecology including its history
- knowledge of the most important Industrial Ecology concepts/theories
- insight in the significance of Industrial Ecology in the societal sustainability debate
- introduction to various definitions and meanings of the concepts 'sustainability' and 'sustainable development'
- overview of the main drivers for un-sustainability

K. Hemmes: Renewable energy systems, Course, 6 ECTS
The lectures provide a general introduction to technical and some non-technical aspects of renewable energy (RE). The lectures also introduce rational energy use, integration and policy issues.
This course aims at providing a first acquaintance with
renewable energy (RE) topics:
- general reference framework for assessing RE technologies
- different technical and strategic RE perspectives
- basic knowledge and instruments for a rudimentary
assessment of RE possibilities and limitations
Upon successfully completing this course, a participant will
have developed the following:
- relevant RE issues and actors (technical and strategic)
- general principles, mechanisms and fundamental and practical limitations of RE conversion, use, storage and integration
- formation, validation and presentation of his/her own
perspective on RE possibilities and limitations

R. Huele: Fundamentals of systems, data, models and computation thinking, Course, 6 ECTS
Behaviour and structure of systems are closely linked: one defines the other, the only disturbing factor being the presence of noise in the signal. Both roads, from data to model and from model to data, will be treated during the course. For Industrial Ecology, two basic families of models are relevant: stocks and flows models and agent based models. Both will be discussed. Skills in working with models will be practised. Much attention will be given to working in an information environment and mastering the relevant formats and software tools
The students will be taught:
1. to build a model from assumptions about system structure, make runs of the model and read the results;
2. to extract and convert data from existing collections and design a model that describes the data;
3. data reduction, presentation and visualisation.

R. Kleijn: Analytical methodologies and tools, Course, 6 ECTS
This course provides knowledge of the most important analytical tools in the area of Industrial Ecology, their philosophy and their position in the field. Students are trained in the applicability of these tools by working on case studies with the aid of specific software-tools.
Study Goals:

- Knowledge of most important tools in the area of Industrial Ecology, their philosophy and their position in the field
- Specific knowledge on four (groups of) tools: LCA, IOA, bulk-MFA and SFA
- Knowledge of applicability of these tools, including possibilities and limitations
- analytical thinking
- defining and refining research questions
- modeling systems including systems definition and setting of system boundaries
- working with LCA databases (ECOINVENT, ETH Zürich)
- working with LCA software (CMLCA, Leiden University)
- working with MFA/SFA software (STAN, TU Vienna)
- working with analytical tools in a societal / policy / business context

E. van der Voet: System Earth, Course, 6 ECTS

The course presents a systems view of the Earth. In Part I of the course, the main processes in the Earth's biosphere are discussed and the working of the climate system is explained. The role of living organisms in maintaining the present state of System Earth as well as the influence of System Earth processes on evolution of the biosphere is discussed. Prominent environmental problems are placed in this context. Part II of the course focuses on the Technosphere, as the source of environmental problems as well as a source for their potential solution. The biosphere-technosphere analogy is elaborated, and concepts like industrial metabolism and industrial evolution are introduced.
Study Goals:
- Knowledge of the main processes of Complex System Earth
- Knowledge of interconnections between biosphere and technosphere
- View on biosphere-technosphere analogy, especially industrial metabolism and industrial evolution
Insight in main IE strategies for sustainability originating from a natural sciences point of view.

F.A. Boons: Social systems – policy and management, Course, 6 ECTS

Industrial ecology deals with the way in which economic activities are coordinated in industrial societies, analyzing the linkages among the producers and consumers of materials and energy. Such linkages may be coordinated through markets, networks, or organizations. In addition, other actors, including governments, seek to influence these linkages, adding public coordination mechanisms such as regulations, subsidies, and taxes to the system. The social system in which material and energy flows are embedded thus consists of a rich variety of ways through which actors can come to coordinated action. These coordination mechanisms can facilitate certain linkages, but in other cases they may impede certain linkages being made.
The course focuses on:
(1) the way in which actors in social systems achieve coordination, a central theme in economic sociology, institutional economics, and public administration.
(2) the way in which coordination mechanisms can be used to increase the sustainability of industrial systems
Taking a problem-oriented approach, coordination mechanisms such as markets, organizations, networks, and various forms of government are explored in theory and through experiential learning of specific management and policy tools. Comparative research will used to explore the importance of the social embeddedness of industrial ecology.
Study Goals:
1. To understand in what way coordination is central to Industrial Ecology
2. To describe and to critically assess economic and social theories of coordination
3. To assess the relevance of a coordination mechanism for specific problem characteristics

E.M. van Bueren: Urban environments and infrastructures, Course, 6 ECTS

With half of the world population living in urban areas and with the building sector as the largest industrial sector in the US and Europe, urban environments and their infrastructures (for transport, energy generation and supply, drinking water provision, waste water collection and treatment, and green infrastructures for biodiversity and livability) make a significant contribution to sustainability problems, in terms of energy use, material extraction, waste production, land conversion, GHG emissions, etc.
In this course, urban environments and their infrastructures are approached from an ecosystems perspective. Framing urban areas as ecosystems helps to identify opportunities for integrated problem solving, i.e. the (re)design of urban areas and their infrastructures. From various disciplinary points of view (water management, energy generation and supply, use and reuse/recycling of materials, transport studies) students are acquainted with the most stressing problems in urban areas at various spatial scales (e.g. building, neighbourhood, district, city, region). They learn about possible conflicts and synergies between sustainable solutions, and between various spatial scales: they are acquainted with often occurring ones and promising combinations and concepts.
Besides the physical design, students are also acquainted with institutional design questions concerning urban areas and infrastructures (government and governance issues, decision-making power, methods and tools for collaborative decision-making, innovative institutional designs to facilitate the design and realization of sustainable urban areas).
This course offers you the unique opportunity to acquire knowledge of sustainable urban areas from an engineering, a design and an institutional point of view. You will acquire knowledge of important sustainability effects of urban areas and of leading methods and tools to assess and address these problems at various spatial scales: ranging from the building level to the urban plan. Also you will be acquainted with the specific institutional context of the built environment and its influence on the innovation and implementation of sustainable technologies.

Study Goals:
To acquire knowledge of the main sustainability issues in the built environment, of leading methods and tools for design and assessment of a sustainable built environment, and of the institutional barriers to the implementation of sustainable technologies and solutions.

L.M. Kamp and J.N. Quist: Sustainable innovation and social change, Course, 6 ECTS
The course consists of three parts:
(1) A theoretical part consisting of lectures, readings and discussions.
(2) A group assignment focusing on a self-chosen system. In the group assignment (i) a brief technology assessment & stakeholder analysis is made before (ii) conducting a more elaborate analysis of the system with either the functions of innovation systems approach or the strategic niche management approach, and (iii) making recommendations how to enhance the current niche.
(3) An individual assignment in which an implementation proposal can be made using one of the intervention & implementation instruments dealt with in the course.
Course Contents
The course Sustainable Innovation and Social Change deals with sustainable innovation and related social change from an Industrial Ecology perspective. It takes as starting points:
(1) that technology and innovation on the one hand and society and users on the other hand mutually influence one another and evolve in a co-evolutionary way;
(2) that sustainable innovations, as well as system innovations and transitions towards sustainability are strongly needed to bring about industrial ecosystems in particular and sustainable development in general, and;
(3) that stakeholder involvement and participatory intervention instruments are needed and required to enable and realise implementation in a socially responsible way.

The course evolves in particular around the concepts of Functions of Innovation Systems, Strategic Niche Management, and Socio-Technical Regimes. A second focus is on participatory intervention and implementation instruments like backcasting, stakeholder dialogues and transition management. These frameworks and instruments can be applied to socio-technical systems, such as regional eco-industrial parks, the niche of organic agriculture and renewable energy innovation systems in both industrialised and developing countries.
The course covers the following topics:
(i) major technology assessment concepts and basis technology assessment methods for exploring technological & social developments as well as analysing stakeholders and impacts;
(ii) innovation system and innovation niche theory and analytical tools;
(iii) system innovation and transition concepts and theories;
(iv) stakeholder theory and participatory intervention & implementation instruments at the level of socio-technical systems like backcasting, stakeholder dialogues and transition management;
(v) how these relate to industrial ecosystems, as well as other domains and emerging innovative niches relevant to the field of Industrial Ecology.

G. Korevaar: Design of sustainable technological systems, Course, 6 ECTS
In this course an introduction will be given on principles and methodologies of sustainable design regarding economic, societal, and ecological constraints. Emphasis is on important environmental and safety issues of sustainable engineering, including legislation, risk, and responsibilities of engineers. The students are trained in evaluating safety and environmental performance of industrial products and production processes. These products and processes will be analyzed regarding the material efficiency and heat integration of unit operations. Tools for pollution prevention and waste management are introduced. Eco-design methods like the natural step, cradle to cradle, and cleaner production are presented and students are trained in their use. The course uses many industrial examples and students will work in groups on real industrial case studies. Design for eco-industrial parks and industrial symbiosis is a major topic in bringing all various aspects and issues together.
Study Goals:
- basic understanding of concepts, methods, and methodologies necessary for assessing, evaluating, and achieving sustainable engineering
- design-aspects of industrial products and production processes
- basis understanding of eco-design methods
- knowledge of principles and methodologies of design for eco-industrial parks
- knowledge of drivers and barriers in processes of engineering and design

N.N.: Elective module, 6 ECTS
Elective modules have to be selected as a component within the first year of the programme, with a minimum of 6 ECTS. Elective Modules are part of a master's programme, i.e. for Leiden University with a level 400 or higher, or for Delft University of Technology a course from a master's programme or comparable.
The content of the course has to be related to the field of Industrial Ecology and the choice for Elective Modules has to be approved by the Board of Examiners before the start of the course.
The Board of Examiners will provide a list, from which students can make their choice. Students that select courses from this list do not need individual approval.

Students can send a request to the Board of Examiners for courses that are not on the list.
The *MIND summer school* between first and second study year is worth 3 ECTS, e.g.

Sum Leiden/Delft first study year: 60 ECTS

Second study year

G. Korevaar: Interdisciplinary project groups, 12 ECTS

In this course, the students do a group project on a real-industrial ecology problem. By problem-oriented education, the students are trained to cooperate with various disciplines and come up with industrial/practical solutions.
Course Contents Continuation
Groups are formed out of the IE students during the 1st year, based on their preferences for one of the available project topics. Topics are prepared in deliberation with staff members of the involved universities and commissioners from external parties.
Study Goals:
Showing the capability to integrate various kinds of knowledge into solutions to Industrial Ecology problems. The project is carried out by following the manual steps.
The result of the project should specifically show
- the analysis of the solution regarding environmental impacts
- the implications of the solution regarding sustainable design and innovation
- the implementation of the solution in a societal or organisational context
Education Method: Project work in groups of four to six students

R. Heijungs: Advanced course on life cycle assessment, Course, 6 ECTS

LCA, or environmental life cycle assessment of products, is a conceptual way of rethinking production and consumption activities in relation to the environmental problems with which they are associated. But it is also a scientifically based method for quantifying these environmental problems. Both as a concept and as a scientific method, it is used to analyse product systems, ranging from packaging materials to entire national energy scenarios, and from building materials to food products from genetically modified organisms.
Although the course basically starts from an applied perspective (how to do LCA?), there is much attention for the scientific foundation and developments. The course puts LCA in the perspective of integrated models, systems analysis, industrial ecology, and society's metabolism of materials and energy.
Study Goals:
This course aims to provide an insight into the various approaches that are somehow deal with LCA. The following aspects are treated:
* the policy and user's context of LCA
* the methodological context of LCA
* an in-depth treatment of the scientifically-based methods for quantitative LCA
* examples of application of LCA
* application of LCA in a concrete case

G. Korevaar: Thesis Preparation Module, Seminar, 6 ECTS

This module results in a literature report, containing a research proposal and research plan for the Thesis Research Project.
Study Goals:
The students
- have to read and understand international literature of a specific topic
- show how their research contributes to the Industrial Ecology field
- write a consistent report, containing a literature overview, a research proposal including problem definition and research questions, and a planning for the Thesis Research Project.

N.N.: Electives, 6 ECTS

The *MIND summer school* between first and second study year is worth 3 ECTS, e.g.

G. Korevaar, E. van der Voet, J.N. Quist: Thesis Research Project **(=Master Thesis), 30 ECTS**

MIND Students have to select, depending on their interest and background, a research topic in deliberation with staff members of one or more of the involved research groups. The student has to work independently on a research project (=master thesis).

The work deals with the following aspects:
- Literature study, problem formulation and planning
- Practical and theoretical work in one of the research groups, including interpretation and evaluation of the results
- Oral and written presentation of the work
The information on research topics is available at "BlackBoard" or available via the Programme Coordinator.

Students can select, depending on their interest and background, one of the following graduation specialisations. The choice for a graduation specialisation has to be taken in deliberation with the the graduation professor. The work on the MSc thesis may include an internship in a company or an institute outside the university examination committee.
– Industrial ecology – integrated systems analysis (primarily in Leiden)
– Industrial ecology – technological systems innovation (primarily in Delft)
– Industrial ecology – organisation and transition management (primarily in Rotterdam)
Goals: Students show in their final research project that they are qualified and able to perform a research in the Industrial Ecology field. In this work they are supervised by staff members of the involved research groups.
The students have to read and understand international literature of a specific topic; are able to work independently on an academic level in a R&D environment; are able to work in an interdisciplinary and multicultural team of experts; and are able to present his/her results in English by means of a presentation to a professional audience and by means of a written scientific report

Sum Leiden/Delft second study year: 60 ECTS

Chalmers University Gothenburg

First study year

S. Karlsson: Science of environmental change, compulsory course, 7.5 ECTS
The course starts with a review of basic chemical, physical and thermodynamic concepts and models appropriate for the description of energy and materials converting systems. Thereafter is dealt with Earth as a materials and energy transforming system; energy conversion processes and the energy balance in the climate system; the composition and properties of and processes in Earth's atmosphere, hydrosphere and pedosphere; the biogeochemical cycles of carbon, nitrogen, sulphur and phosphorus.
Interlinked with the natural science parts, the course discusses the fluxes induced by human activities in the industrial society and different disturbances of the environmental system. Special attention is drawn to fresh water utilization and pollution; the disturbances of the carbon balance and cycle, the greenhouse effect and its connection to our energy supply and use; the disturbances of important nutrient cycles as sulphur, nitrogen and phosphorus, eutrophication and acidification; chemical processes and turnover of different pollutant in the atmosphere, including the ozone layer attenuation. It is finally dealt with different possible ecological mechanisms and effects of resource utilization in biological systems.

B. Sanden: Technical change and the environment, compulsory course, 7.5 ECTS
The first part of the course puts the current industrial society into a historical context. A 10,000 year history of the relationships between Technology, Society and Nature is briefly explored and the evolution of the industrial society is studied in more detail. In the second part, different theoretical frameworks that can be used to understand the process of technical change are discussed, including economics of innovation and historical and social studies of technology. The third part deals with how an understanding of technical change can be used in future studies and environmental policy design, in particular climate policy.

Organisation:
The course is organized as a series of lectures and seminars. The lectures present selected parts of the literature and complement the literature with additional material. At the seminars, some topics are discussed in greater detail. These seminars are compulsory. Written assignments are given during the course.

G. Berndes: Sustainable development, compulsory course, 7.5 ECTS
The course starts with a block of lectures giving perspectives on the concept sustainable development and on Man-s interaction with nature from a historical perspective. Environmental ethics and intergenerational justice are discussed. After this, lectures are dedicated to providing systems perspectives on human-nature interactions and the societal metabolism in a sustainable development perspective.
A second block of lectures concerns sustainable land use, including food and agriculture as well as forestry, and sustainable materials systems where analytical tools and methods in industrial ecology are surveyed. Specific lectures are also dedicated to sustainable development and technical change, and to the Kyoto protocol and connected international processes.
In a third block of lectures - working for sustainability - guest lecturers are invited to meet with the students and present their own experience of working for sustainability in various functions in society. Earlier themes include environmental diplomacy, environmental NGO work on eco-labeling, Agenda 21 work in Göteborg and implementation of sustainable agriculture in the context of the EU common agricultural policy. Parallel to the lectures, seminars are arranged providing opportunities for the students to discuss and learn more about specific topics of relevance for sustainable development. The seminars are compulsory and the students prepare for the seminars by completing tasks that are distributed by the teacher during the weeks before the seminars.

U. Palme and A.N. Claesson: Environmental systems analysis, compulsory course, 7.5 ECTS
Environmental Systems Analysis comprises the collection, analysis, integration, valuation and interpretation of information on how technical systems cause or contribute to environmental problems. There are a number of different tools to perform such studies, for example Environmental systems analysis (ESA) comprises the collection, analysis, integration and evaluation of information on how technical systems cause or contribute to environmental problems. It is used to support decision-making in many different areas like industry, public sector and government. The focus can be on technical solutions as well as on policy, plans and legislation related to the design and use of all kinds of technical systems. Examples of some common ESA tools are environmental risk analysis, life cycle assessment, environmental impact assessment, and material flow analysis.
The course aims at introducing the theoretical framework of the tools and methods, and to provide the knowledge required to choose a relevant tool or method and formulate the goal and scope for a specific application. The course also introduces and defines a set of concepts needed for a good understanding of environmental systems analysis.
One important part of the course is the critical appraisal of results by discussing why different investigators may get different results with the same tool, pointing out the importance of the choices performed. To be able to analyze this, it is important to understand the applications of the ESA tools and methods, what actors can benefit from the results produced by different tools, and in what context they yield meaningful information.

H. Baumann and A.N. Claesson: Environmental management, compulsory course, 7.5 ECTS
The course is focused on the corporate environmental management and is given as a series of lectures. These involve the environmental factors of the corporate environmental management (stake holders, environmental legislation etc), the starting points for the environmental work (incentives, environmental strategies etc) and processes and tools (environmental management systems, environmental revision, environmental accounting etc) A project work and a study visit is included in the course.

T. Sterner: Environmental policy instruments, compulsory course, 7.5 ECTS
The course will give an overview of why economics policies are needed in the area of pollution and resource management as well as a survey of the policy instruments that are available. Finally it will explain theories of policy selection and design. Considerable attention will be paid to integrating economic modeling with actual issues in real economies.
The course will be based on Sterner, T., Policy Instruments for Environmental and Natural Resource Management, RFF press in collaboration with the World Bank and SIDA, Washington DC, November 2002(ISBN 1-891853-13-9 and ISBN 1-891853-12-0).

A.-M. Tillman and B. Sanden: Life cycle assessment, compulsory course, 7.5 ECTS
Life Cycle Assessment (LCA) is a method for the analysis and assessment of the environmental impact of products. The life cycle perspective comprises raw material acquisition, production processes, use and waste treatment. LCA comprises calculation of the environmental load associated with the product under study, life cycle impact assessment and interpretation of the results. The course includes LCA methodology and applications. The application and use of LCA by different actors is covered.

U. Lundqvist: Applied industrial ecology, compulsory course, 7.5 ECTS
The course includes:
- the concept of Industrial Ecology;
- a set of analytical tools and methods applied in Industrial Ecology that apply a systems perspective to analyse and suggest measures for societal and industrial activities and their impact on nature: material flow analysis, indicators, technology assessment;
- students' presentations of the industrial metabolism of a set of materials from a sustainability perspective;
- students' presentations of the results of technology assessments of a set of technologies (products) from a sustainability perspective.

Sum Chalmers first study year: 60 ECTS

Second study year

Sustainable energy futures, compulsory course

Study period 1, year 2, 7.5 ECTS

The course should give the student knowledge of the general development of the energy system (past development and outlook for the future), its environmental and resource impacts, as well as tools to analyze these developments.
The overall aim of this course is to address the following questions:

- How will climate change policies reshape the world energy system over the next century?
- What role may increased energy efficiency, renewables, fossil fuel and nuclear power, play in the near and long

term future if the climate challenge is to be met?
- In which sectors are limited energy resources most efficiently used, e.g., should biomass be used for transportation fuels or for heat production?
- Which climate policies are needed for a cost-effective solution to the climate challenge?

The aim is to illustrate these issues by drawing upon recent research in the area, and based upon this to discuss and problematize existing visions for a sustainable energy future.

Strategic environmental assessment, elective

Study period 1, year 2, 7.5 ECTS

The aim of the course is to introduce the student to the concepts and practices of strategic environmental assessment. The course also aims to give the student an understanding of the contexts of decision and policy making of strategic actions. The course seeks to bring together students from different disciplines and with different cultural backgrounds to train students ability to work across scientific disciplines and cultural contexts; from engineering, natural sciences and social sciences; from developed and developing countries. After completion of this course, the student should be able to:

- define the context to decision making processes; the political, legal, economic and ecological systems.
- define strategic actions - policies, plans and programs, and explain their roles in relation to societal objectives.
- identify and describe the relationships between different policies, plans or programmes, for example between a strategy for growth and a spatial strategy for a region.
- explain in why environmental considerations have not been appropriately integrated in the decision making of strategic actions, and exemplify by indicating in real situations which are the procedural, process and institutional factors that affect the outcome (meeting environmental objectives) of the strategic action.
- explain why and how environmental information needs to be adapted depending on the level of strategic action.
- identify what factors that has to be taken under consideration when designing a strategic environmental assessment procedure, in real situations.
- appraise the outcome of a decision making process of a strategic action based on the principles for strategic environmental assessment.
- describe how strategic environmental assessment approaches can be adapted to different contexts; to different levels of decision making; in developed and developing countries; in different institutional settings.
- work in crossdisciplinary teams.

Environmental impact assessment, elective

Study period 1, year 2; 7.5 ECTS

The course will give advanced knowledge on Environmental Impact Assessments in an international perspective. Focus will be on the processes and methods used to implement the goals of EIA. Examples on how the EIA process is carried out in different countries will also be included. Training in methods and project work is also given. The course is based on lectures, seminars, exercises, excursions and project work. The course is structured around a set if initial lectures with adjoining exercises that will illustrate important aspects.

Sustainable power production and transportation, recommended elective

Study period 1, year 2; 7.5 ECTS

Prerequisites: Basic knowledge in electrical drives, power systems and use of Matlab on Bachelor level. Recommended course at Chalmers is EEK140. The course aims to provide the students with advanced and state-of-the-art developments in wind power, photo voltages, wave power and hybrid electric vehicles, dwelling both on the theoretical fundaments as well as building a good practical and experimental basis. The goal of the course is also to give the students a deep knowledge about the modelling, design and control of the electric system for hydro, wind, wave, and solar power. The electric system in electric or hybrid-electric vehicles will also be treated. The understanding of the grid interaction of these power sources and consumables is also an important goal.

Environmental aspects on logistics and transportation, recommended elective

Study period 1, year 2; 7.5 ECTS

The aim of the course is to provide the student with knowledge and "State of the art" in the field of environmental aspects of logistics and freight transport.

The intended learning outcomes of the course are to be able to define sustainable development for the freight transport sector; explain the unsustainable impacts of the freight transport sector; sketch the energy use and emissions of transport

chains; judge measures and actions for environmentally responsible logistics; and compose strategies towards sustainable logistics.

The lectures will be about three main sectors: Sustainable freight transport; Life Cycle Assessment of the transport sector - A total analysis of energy use & emissions from the transport sector; environmentally responsible logistics.

Industrial energy systems, recommended elective

Study period 2, year 2; 7.5 ECTS

The aim of the course is to train students to use process integration methods and tools necessary for identifying and designing efficient industrial process energy system solutions that contribute to sustainable development.

Besides understanding technical and economic issues, students will also achieve understanding of the impact of industrial process energy usage on the greenhouse effect, and the role that industrial energy systems can play with respect to meeting greenhouse gas emissions reduction targets.
The course addresses use of methods to identify the cost-optimal mix of different process heating technologies to satisfy a given process steam demand. One important aspect is how future energy policy instruments will influence these optimal solutions. Technical systems encountered in the course include heat exchanger networks, boilers, heat pumps, combined heat and power systems, and thermal separation units.

Fuel cells - function and materials, recommended elective

Study period 2, year 2; 7.5 ECTS

The course aims at giving a fundamental understanding of the function and materials of fuel cells, materials properties and components. What is needed to make the technique commercially available will be discussed. The interest for fuel cells has increased considerably due to their potential for mobile and portable applications as well as for stationary power production. The most important advantages of the fuel cell technique are the high efficiency, low emissions and noise level. The course treats the basic principles of the fuel cell technology and performance will be described from a thermodynamic perspective. Different types of fuel cells will be discussed, e.g. the polymer fuel cell (PEM), the phosphoric acid fuel cell (PAFC), the molten carbonate fuel cell (MCFC) and the solid oxide fuel cell (SOFC). Also new types such as the intermediate temperature solid oxide fuel cell (ITSOFC) will be treated. Materials, ion and electron transport, performance and analysis will be focused. Balance-of-plant, fuels and fuel reforming as well as related aspects concerning for example hydrogen safety will also be taken into consideration.

Waste management, recommended elective

Study period 2, year 2; 7.5 ECTS

The ultimate goal should, of course, be that no waste is formed in industry or society. But in the foreseeable future, activities in the industry and society will produce waste. An important step towards a sustainable society is a proper waste management with the goal of utilizing the waste material in best possible way. The purpose of this course is to train the students in different waste management techniques. A special emphasis will be on techniques for transformation of waste materials into products that can be beneficially utilized.

Sustainable electric power systems, recommended elective

Study period 2, year 2; 7.5 ECTS

Prerequisites: Mathematics (including Linear algebra, Numerical analysis, Mathematical statistics and Multivariable analysis) and basic knowledge in Environmental science/engineering.
The overall aim of this course is to provide an understanding of the complex technical system with main function to deliver electricity between generation, consumption and storage, i.e. the electric power system. The intended learning outcomes are to be able to:

- Conceptually describe the technical characteristics and performance of the electric power system with main function to deliver electricity between generation, consumption and storage.
- Carry out basic electric circuit modeling and analysis
- Understand the basics of synchronous generators
- Understand the basics of the three phase transmission system
- Understand basic impact of different loads on the electric power system
- Formulate and solve a power flow analysis problem

- Understand the fundamental behavior of the Electric power system with use of simulator tools.
- Perform basic reliability studies of electric power systems
- Perform basic market modeling of electric power systems
- Understanding the use of power electronics in electric power systems
- Understand and follow safety instructions in the electric power engineering lab in the course.

Project management for sustainable development, elective
Study period 2, year 2; 7.5 ECTS

No description available, yet.

Assessing sustainability, elective

Study period 2, year 2; 7.5 ECTS

The course introduces a set of concepts and systems methods necessary for the professional working with environment and sustainablity issues at different societal levels, from local to global. A particular focus is on the way sustainability is perceived, indicated and assessed using various analytical procedures ("tools"). In individual assignments students investigate different assessment themes of relevance for sustainable development (SD) in order to present and give background to group discussions on the detection, quantification, mitigation and prevention of environmental and resource problems including their relation to the broader concept of SD. Therefore the course is focused on, but not limited to, environmental aspects of SD. The multicultural background of the participants is an important assesst dealing with these issues.

Sum Chalmers third semester: 82.5 ECTS (30 ECTS to be taken)

Study periods 3 and 4, year 2 (=summer term of 2nd year, fourth semester)

Master Thesis, 30 ECTS

Possible topics for Master's theses in the MIND programme at Chalmers University of Technology.
The topic of your Master's thesis has to be relevant for the MIND programme, i.e. Industrial Ecology. However, since Industrial Ecology is a broad field there are many possible topics.
When doing your Master's thesis at Chalmers, you have to have an examiner (supervisor) at one of the research departments of Chalmers.
The descriptions of research going on at the different departments can give you an idea about possible topics.
There are 17 research departments at Chalmers. Most of these departments include some research that is relevant for Industrial Ecology, and therefore it is possible to do your Master's thesis there:
http://www.chalmers.se/en/research/Pages/departments.aspx

The department Energy and Environment, which includes six divisions, has a lot of research going on that is relevant for Industrial Ecology: http://www.chalmers.se/ee/EN/

Sometimes suggestions of Master's thesis are posted by the researchers, see e.g.:
http://www.chalmers.se/ee/EN/education/master-theses-projects

However, it is also possible (and more common) that students contact researchers and ask about possibilities for Master's theses.
Here you can find a list of previous Master's theses performed in the local Industrial Ecology programme at Chalmers:
https://student.portal.chalmers.se/en/Studies/MasterProgrammes/IndustrialEcologyforaSustainableSociety/Pages/Archiveofmastertheses.aspx

As of 1 April 2015