

Urban metabolism and resources

ACE155

Course description 2021

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Master Programme Infrastructure and Environmental Engineering 2021

Master Programme Industrial Ecology 2021

Water Environment Technology, Architecture and Civil Engineering

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The image of the world around us, which we carry in our head, is just a model. Nobody in his head imagines all the world, government or country. He has only selected concepts, and relationships between them, and uses those to represent the real system. (Jay Forrester, 1971)

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Introduction

The vision of a sustainable city includes modern buildings and vehicles, a vibrant economy, balanced urban ecosystems and healthy living. In addition, the city's pressure on the local and global hinterlands is expected to be minimized. In reality, the trend is towards growing pressure from urban areas on their hinterlands, as a result of an increase in resource intensity due to growing populations and an increasing affluence of urban dwellers.

Urban Metabolism is a field in engineering that aims to reduce the pressure put on hinterlands, whilst still achieving the vision described above. Urban metabolism is used as a metaphor for the resource consumption of cities, as a city requires input of energy, water and materials to exist and grow just like a living organism, and also produces waste. In Urban metabolism studies the inputs, outputs and storage of energy, water, nutrients, materials and wastes for an urban region are investigated and different tools are used to optimize resource consumption and decrease the associated environmental impacts.

Course aim

Students should gain knowledge and skills about the functioning of cities and regions in terms of their infrastructures, resource use and waste production in order to:

- assess performance of contemporary cities
- suggest and evaluate necessary transformations
- meet challenges of global urbanization, resource scarcity and environmental degradation

The course presents the main concepts about the following methods and tools: **Material Flow Analysis, Input-Output Analysis, Industrial Symbiosis, Circular Economy, Sharing Economy, Entity relationship model, Geographic Information Systems and Water footprint.**

Learning outcomes

After completing the course, the students should be able to:

- explain critical aspects of sustainable development for urban areas with focus on environmental impacts and resource constraints;
- study urban technical systems, including water and transportation systems, and resource flows to identify eventual problems in relation to sustainable development;
- suggest improvements to technical systems, technology, resource management and lifestyles that may enable efficient resource use, mitigate climate impacts and prevent pollution;
- simulate, predict and evaluate the effect of suggested improvements in urban systems on resource flows and the environmental impact.

Course content and organisation

The Urban Metabolism course is built upon: lectures on key aspects of Urban Metabolism, workshops, individual essay assignment and group project, as described below.

Lectures

A series of lectures on relevant topics will be given to support knowledge development. The lectures should provide basic concepts in specific topics, as well as contextualization for these topics.

- **Urban metabolism trends, Urban Metabolism framework, Economy-Wide MFA method, Environmental hotspots, Industrial Symbiosis**, Leonardo Rosado
- **Urban water resource management**, Sébastien Rauch
- **Sharing Economy, Strategic literature search**, Divia Jiménez Encarnación
- **Entity relationship modelling**, Jonathan Edgardo Cohen

Workshops

Workshops consist of practical exercises in which the students will learn the different approaches, methods and tools. In the workshops that accompany a lecture on the topic, students will learn how to approach components of the group projects and the individual assignment. Students will be asked to submit to Canvas the completed workshop assignment (mandatory).

A set of six workshops will be made:

- **Material flow accounting, Circular Economy strategies, Input-output methods**, Leonardo Rosado
- **Urban water resource management**, Sébastien Rauch
- **Strategic literature search**, Divia Jiménez Encarnación
- **Geographical Information Systems**, Jonathan Edgardo Cohen

Individual assignment

The goal of the individual assignment is for students to consolidate the material presented during the course and complement it with new knowledge found individually.

The individual assignment is a literature review about the contribution of the urban metabolism field of research for the transition to circular economy in cities. Write an essay of no more than 2500 words (not counting title page and reference list), including your strategic literature search method.

You may use the points below to develop your essay. We expect you to reference the most significant papers you find using the strategic literature search.

- What tools and methods fall under the urban metabolism field of research?
- Considering that a proper approach to ensure sustainability in cities is to be able to: **describe** the urban system quantitatively; **identify the drivers** of resource use; **suggest strategies** for transition to circular economy; and to make sure the urban system is properly **monitored**, classify and organize your methods and tools in terms of their purpose.
- Discuss the level of detail the methods and tools identified have, and if they are enough to support the transition to circular economy. Discuss the spatial scales, the involvement of stakeholders, types of environmental impacts, among others.

- Reflect on your findings and suggest further improvements to strengthen the urban metabolism approach.

You can draw a mind map to identify key concepts presented in the papers and show how they are connected. Examples of the concepts: hinterland, limits to growth, dematerialization, decarbonization, circular economy, service economy, resource efficiency and productivity, industrial symbiosis, urban mining, etc.

Major points made should be supported by citation. References for statements of fact should be noted.

Essay writing tips

An essay is a structured text that may be used to describe, argue, analyse, explain and critique concepts, ideas, and more. The essay should have a clear purpose (not just fulfilling an assignment), and a thesis statement that summarizes the main point you will make in your paper. An essay is typically structured with an introduction, body, and conclusion. It is a good idea to outline your ideas prior writing the whole text so that you have a cohesive, logical flow and structure to your analysis.

Be sure to continually provide evidence for the statements made in the essay using the references provided or that you have found on your own. We would like you to use the APA reference format, see recommended resources.

Recommended resources if you feel stuck:

- APA Citation guide: <https://www.mendeley.com/guides/apa-citation-guide>
- Chalmers writing guide: <http://writing.chalmers.se/en>
- Harvard Writing Center: <https://writingcenter.fas.harvard.edu/pages/resources>
- NUS writing guide: <http://www.nus.edu.sg/celc/research/books/cwtuc/chapter01.pdf>

Group Project

The group project is organised as a problem-based learning project with focus on urban areas. The expected learning outcomes from the group project are to:

- make simple models of technical systems and resource flows and identify eventual problems in relation to sustainable development;
- quantify resource flows;
- suggest, simulate, predict and evaluate impact of changes to the economy and industrial structure, lifestyle and the built environment;
- select urban design, urban form, materials and building technologies that enable efficient resource use.

The topics will be proposed by the supervisors and introduced in a lecture during the first week. The registration for projects is through Canvas. Each group will have limited number of students, and will be filled on a first-come, first-served basis. A description of each project will be uploaded to Canvas after the lecture.

The project deliverables include a final report, presentation and opposition to another group. The final report should be max. 7500 words. The report should be written as a technical/scientific report in English and should contain the following items:

- cover-page (full title, your and the group supervisor names, course and date)

- abstract (a summary of the purpose, results and conclusions)
- table of contents
- **introduction (briefly describe the problem and the causes of the problem)**
- **aims and objectives**
- **descriptive information (description of the case study)**
- **background information (description of selected literature information)**
- **method**
- **findings or results**
- **discussion (critical evaluation of information presented above)**
- **conclusions (the most important findings and recommendations)**
- reference list

Note that the max. number of words provided above are for the introduction, aims and objectives, descriptive information, background information, method, findings/results, discussion and conclusions (in bold above), excluding cover page, abstract, table of content and reference list.

The groups have regular consultation meetings with the supervisors, these meetings are mandatory. When needed, you and your supervisor have the possibility to plan additional meetings or meet on different dates.

Throughout the group work, the students must submit their work, as specified in the course schedule. The submissions of all the versions of the reports at different stages are mandatory, since the meetings with the supervisors will be based on discussions of the reports.

Presentation

Presentations of the group projects will be made on specified in the schedule dates and should be in English. The presentations will be followed by an opposition by another group. Each presentation should be up to 15 minutes. It is expected that all group members participate in the presentation seminar, but it is up to the group to decide who does the presentation, and who does the opposition. The presentation should be presented both orally and in the format of a PowerPoint. Presenters should be prepared to answer questions from anyone in the audience, not just the opposition group.

Opposition

Each opposition should be up to 10 minutes. The opposition is only done orally. The aim of the opposition is to improve the work you are opposing, so that your fellow students can advance in their skills in writing scientific reports and delivering interesting oral presentations. Your task is to give constructive criticism and evaluate the strong and weak points of the work. Your questions should open up for a fruitful discussion, covering the aims, methods, results and conclusions in the report and the performance of the oral presentation. Opposition is also considered a learning moment.

The following questions are examples of important points to consider in your critical review of another group's work:

- The starting point for the report and the presentation? Problem definition? Are the problems clearly and well defined?
- Analysis of the problems? Hypotheses and scenarios? Are the defined problems, hypotheses and scenarios handled well in the report and during the presentation?

- Scientific depth in the report and the presentation? Synthesis of the problem or more or less copy and paste from the literature? Tables and figures made by the group members? Are conclusions and discussions well related to the measurement results and the built-up hypothesis and scenarios?
- Organisation of the report and the oral presentation? Formalities? Language?

The opposition should be presented orally. This list of questions will also be considered when the teachers grade your work. Please also read through the document “Opposition guidelines”.

Writing guidelines

Report writing

For report writing please read “**Writing guideline for reports, BSc theses, MSc theses at Chalmers University of Technology**” (*shared in Canvas*). Number all tables and figures; table notations above the tables, and figure captions below the figures. Refer to all tables, figures and references in the text. Summarise and discuss them in the text and make conclusions from the results. When writing the report, *you must use your own words* (no copy from references) and cite (in-text) the references you use. Follow the Harvard system (author-date) for in-text citation. This means that the author's last name and the year of publication should appear in the text, e.g. “Safe water is key to sustainable development (Jones, 1998)” for one author, (Jones and Smith, 1998) for two authors, or (Jones et al., 1998) for three authors or more. It may also be on the format: “According to Jones (1998), Safe water is key to sustainable development”. A complete reference should appear in the reference list at the end of the report. The complete reference implies that you give the information needed for another person to find that reference (e.g. URL for Internet sources, complete report title, publisher, ISBN etc.).

Plagiarism

Direct copying from the Internet, literature or your classmates is strictly prohibited!!

We verify all assessments via the Urkund system. Urkund controls all documents submitted against three main sources; the Internet, published material, and Urkund archives (e.g. reports from previous years). All documents, which are controlled through the system, are stored in Urkund archives and prevent plagiarism from former and fellow students. For further information, please read the document “Academic honesty and integrity at Chalmers”.

Literature

The following reading is suggested for this course. Additional optional literature can be provided on Canvas course page.

- Kennedy, C., Cuddihy, J., & Engel-Yan, J. (2007). The changing metabolism of cities. *Journal of industrial ecology*, 11(2), 43-59.
- Kennedy, C., Pincetl, S., & Bunje, P. (2011). The study of urban metabolism and its applications to urban planning and design. *Environmental pollution*, 159(8), 1965-1973.

- Kalmykova, Y., Sadagopan, M., & Rosado, L. (2018) Circular economy—From review of theories and practices to development of implementation tools. *Resources, Conservation and Recycling*
- Kalmykova, Y., Rosado, L., & Patrício, J. (2015). Resource consumption drivers and pathways to reduction: economy, policy and lifestyle impact on material flows at the national and urban scale. *Journal of Cleaner Production*
- Barles, S. (2010). Society, energy and materials: the contribution of urban metabolism studies to sustainable urban development issues. *Journal of Environmental Planning and Management*, 53(4), 439-455.
- Demailly, D., and A.-S. Novel. 2014. The sharing economy: make it sustainable. *Studies*, 3.

Further information can be found from a variety of sources, including scientific journals (available from the Chalmers library website), books and the internet. We recommend you ensure that the information you get (especially from the internet) is reliable.

We recommend the use of scientific databases available on the Chalmers Library website, including Science Citation Index, Scopus, ScienceDirect and Springer Link.

Schedule

The schedule for the course is detailed on the ACE155 course schedule pdf file.

Communication

We ask for communication between students and teachers is made through Canvas messages or email using Chalmers credentials (Chalmers email).

For group work, students should identify a spokesperson that communicates with the supervisor. Teachers will reply to students' enquiries as soon as possible.

Assessment and grading

Continuous assessment is the main examination form in this course. Grading is based on the individual assignments and the group work, as well as on the active participation in the course. You are expected to actively participate and contribute to the group work. Submission of all assignments is compulsory. In the case of missing submission, the student will not be approved for the course.

The final grade is F (fail), 3, 4, 5 with 5 being the highest grade. The grade for the group work is the same for all the group members.

Assignment	Component	Percentage of final grade
Individual assignment	Essay	40%
Group work	Report	45%
	Presentation	10%
	Opposition	5%
Workshop assignments	Exercises	Pass/Fail