

## PhD course

### FMG3210 - Circular Economy and Industrial Systems (7.5 Credits), 2020

<b>Meeting dates</b>	February 4, 5, 6 and <del>May 12, 13</del> May 26, 27 in the year 2020
<b>Meeting venue</b>	Room M311, Brinellvägen 68, KTH Royal Institute of Technology Stockholm
<b>Course registration</b>	For registration please send an e-mail to Sayyed Shoaib-ul-Hasan at <a href="mailto:ssuh@kth.se">ssuh@kth.se</a> . Deadline for course registration is <del>15<sup>th</sup> January 2020</del> 31 <sup>st</sup> January 2020.
<b>Course fee</b>	Doctoral students (both regular and industrial) enrolled at KTH can join the course free of charge. For external doctoral students and industrial participants there is a course fee of <b>6000 SEK</b> .

#### Course rationale

The term “Circular Economy” (CE) which could be described as one of many mechanisms for a transition to a sustainable development has become a hot topic in academia, industry and policy circles. In simple terms, CE has its point of departure in sustainable production and consumption although the main focus thus far is on the supply side. Its goal is to result into ways of optimizing materials cycles from raw materials to their disposal within an industrial system. Depending on the academic field, the industrial practices and policy contexts, there are diverse definitions of CE and it has some family resemblances with other sustainability related terms (e.g. cradle to cradle).

From a policy perspective, CE has become pervasive and is viewed as an important approach to fundamentally transform the economy away from its addiction to carbon and steer towards sustainable life styles and means of production. Several nations are now investigating governmental actions for transforming their economy towards a circular economy and in the Swedish context, for instance, on the 27th of March, 2017, in a highly-publicized report commissioned by the government, specific policy incentives to promote CE were recommended.

At the industrial level, the notion of circularity in material, energy and economic flows could be viewed as a paradigm shift to quote Kuhn (1962) with implications for industrial and technological transformations for both incumbent and future industries. For incumbent industries, one implication of the adoption of a circular approach is to overhaul material and energy flows to pave the way for sustainable production. In this context, the ambition is that future industrial production will be emission free with self-reinforcing closed loops and retake and recycling as recovery options. In addition, it is expected that CE will result in new business ventures and business models. This demands a holistic focus in which all the value chains of the industrial system will be impacted. For instance, if circularity alone is seen as the goal there is a risk of circular production systems and business models leading to environmental sub-optimization, with high material circularity at the expense of increased impact in other areas. Therefore, impacts over the full life cycle need to be considered. While Life Cycle Assessment (LCA) is in principle applicable to any type of product or service system, the methodology meets certain challenges when applied to circular systems.

However, the notion of CE is still in its infancy although its philosophical undertones can be traced to more than half a century ago. The research on it has just begun to emerge but is somehow fragmented. The literature thus far has mainly been on the systems, policy levels and

individual country studies). It is however clear that both as a research area and even more important for transforming towards a circular economy in practice, CE is a subject that needs to be treated from several different perspectives. It is truly multidisciplinary and affects more or less all functions and roles in an organization.

### Learning objectives

Against this background, the aim of this PhD course is to provide the foundations of the circular economy paradigm. More specifically the learning objectives of the course are:

- Provide *conceptual* frameworks necessary to understand the foundations of the CE
- Give insights into current *industrial trends* regarding CE
- Provide the *policy rationale* for CE

### Course outline

The course will be a combination of lectures, discussions and students' own work. An important mechanism for learning is individual reflections and relating theory to practice. A number of learning goals are defined for the course. After attending this course, PhD candidates will be able to:

- discuss the conceptual frameworks necessary to understand the foundations of the CE;
- outline current industrial trends regarding CE;
- adopt a system perspective for implementation in industry and society and discuss opportunities and barriers in an implementation;
- relate to the policy rationale for CE.

### Activities

The course is organized in two meetings spread of 5 days with candidates' own work in between. An essay is written for the course, which could be written as a first draft of an academic paper if so preferred. Several short assignments are expected as well.

During the first meeting in the course the basics of CE is given and themes relevant for both research in the area and its implications in practice will be presented, see Box 1. In addition to these presentations, literature will be introduced which will form the foundation of the individual work of the candidates. At this time, the candidates are also defining their individual work, which could be related to their own research studies and/or an industrial organization.

In the second meeting the concept of Circular Manufacturing Systems will be introduced through an innovative board game.

During the third meeting of the course industrial cases will be presented in order to provide a foundation on practical challenges/opportunities different organizations face. The cases will also outline relevant changes that different organizations need to make in order to succeed.

During the fourth meeting the concept of Co-Creation will be introduced. The final meeting comprises seminars where students are presenting their work. Figure 1 illustrates the course outline.

**Attendance in all activities is mandatory.**

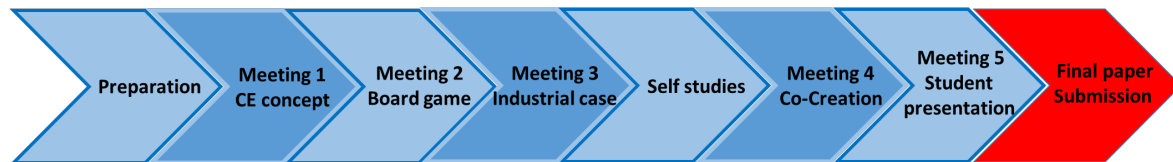


Figure 1. Structure of meetings and work in between in the course.

Observe that pre-reading and individual/group work is expected before the first meeting as well as during the course so allocate time before the first meeting. Attendance in all activities is mandatory.

The preparation required before the start of course is to give a short description of your own research studies and to read beforehand papers provided from the course management. Following on that the major assignments for students taking the course are to review literature in the area, analyze an industrial case and write a paper/essay relating to trends in circular economy, challenges for a transition or on specific circular economy problem.

*Box 1. Themes in the course – theory and practice*

**Theme 1: Circular Economy - The Concept and its Limitation in a sustainability perspective**

The objective of this address is to make sense of the actual concept of circular economy from the perspective of sustainable development. Further, the contribution will identify and discuss some of the main limitations and challenges of the concept in light of corporate sustainability and strategic considerations within corporate sustainability management.

**Theme 2: A systems approach for developing a theoretical base for CE studies**

Established methodologies such as life-cycle assessment and simulations build upon systems analysis which serves to aggregate and analyze multiple variables and complex systems. A theoretical foundation is in a profound need of a multidisciplinary research. This theme highlights the critical approaches needed in understanding the area at a theoretical level and for monitoring and evaluating CE initiatives.

**Theme 3: Closed loop manufacturing in the context of Circular Economy**

Closed loop systems are characterized by integration of forward and reverse supply chains where the loop of product flow is closed by intention or design. This approach implies that for efficient and effective reuse of resources the products should be designed for multiple lifecycles and marketed through business models where both the value delivery and recovery are planned parts of the system.

**Theme 4: Operations and supply chain management in a Circular Economy**

Given a shift towards a circular economy, how will this impact operations and the supply chain? What are the unique managerial challenges in reverse operations (e.g. remanufacturing and recycling) and what business opportunities await on the other side of these challenges? This theme focuses on strategy and managerial decisions at the functional level and reflects on the challenges in implementing ambitious corporate visions.

**Theme 5: Designing Circular Industrial Systems and the need for innovation management**

As also stated above, designing the industrial systems is one core in developing circular industrial systems. In this theme, we look into the design principles for closing material loops but focus even more on the innovation capabilities of firms. Managing for disruptive innovation is a clear need in a transition to circular economy.

**Theme 6: Chemical engineering for resource recovery in a circular economy**

Creating economically and environmentally sustainable processes for resource recovery from primary and secondary raw materials is one of the challenges in realizing a circular economy. There is a need to develop new techniques and processes for resource recovery. This includes using biochemical tools for resource recovery from wastewater and hydrometallurgy for recovery of valuable elements from consumer products and other waste streams (e.g. NiMH batteries and red mud).

This course is provided from CE@KTH, an initiative to coordinate and support research and education in the area of Circular Economy. Course responsible are Amir Rashid and Sofia Ritzén, who can answer any questions about the course.

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