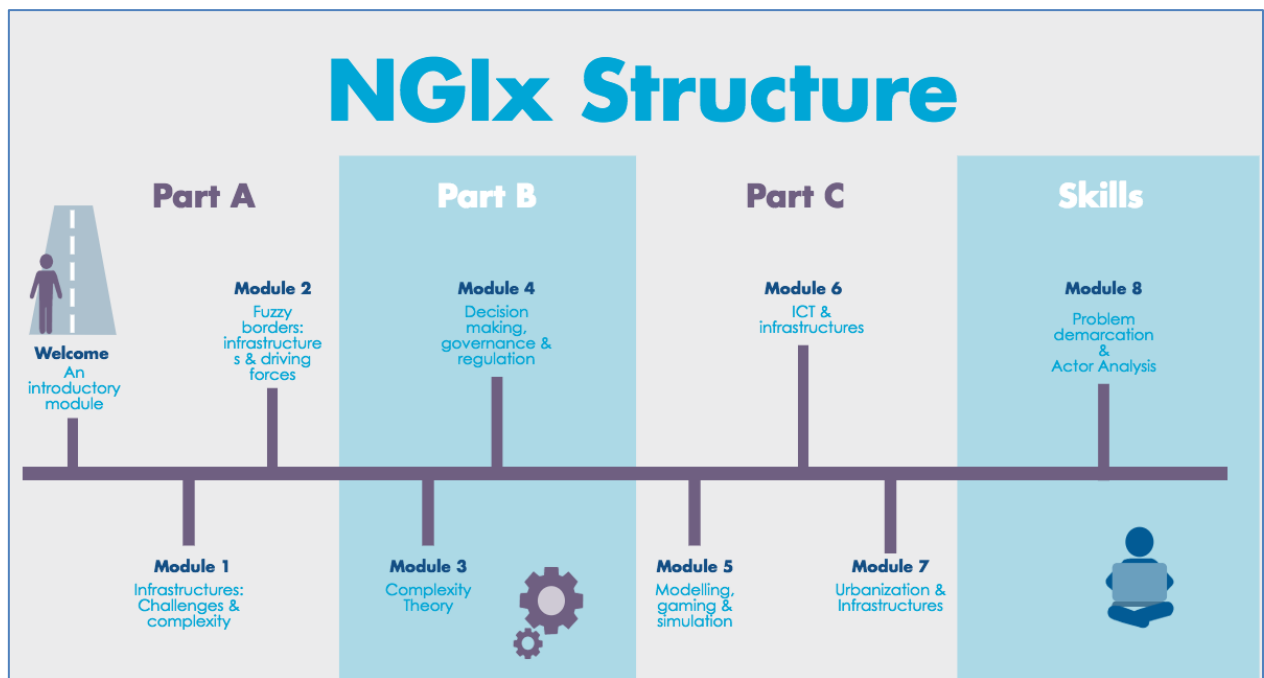![TU Delft — Delft University of Technology logo]

Course Syllabus – Next Generation Infrastructures (NGI)
Self Paced 2016/17

Structure of the course

Part A:

- *Module 1: infrastructures: challenges and complexity*

In this module, we will first describe the major challenges when it comes to infrastructures, and show you some examples. After that, we will explore the complexity of infrastructures and show you what we call infrastructures complex adaptive systems or socio-‐‐technical systems. We will illustrate that this new perspective is essential for understanding the structure, problems, challenges and the behaviour of today's infra-‐‐systems. To mark the difference with the traditional perspective we will often speak about infra-‐‐systems instead of infrastructures. To mark the difference with the traditional perspective, we will often speak about infra-‐‐systems instead of infrastructures.

Our case study concerns the energy transition in Germany following the nuclear disaster in Japan in 2011.

- *Module 2. Fuzzy borders: Infrastructures and driving forces*

In this module, we will discuss the complexity of infra---systems in much more detail. We will address the main developments. Think about the evolution of infrastructures over time, 'system of systems' (interconnectedness water, energy, transport), internationalization, interoperability & convergence and 'inverse (bottom---up) infrastructures (for example, solar panels in a local community). As bonus material, we will give you insight in the process of standardization.

Part B

- *Module 3: Complexity theory*

In module 3, we will focus on the general theory behind complex systems (complexity theory): what are the characteristics? What does this mean for decision--making?)

- *Module 4: Decision making, governance and regulation*

In this module, we will discuss decision---making in a multi--actor setting/complex environment and the meaning of public values behind infra---system performance and the trade---offs to be made between them as well as some pitfalls. We will show you how public values go through a transformation process: from a feel---good concept to explicit measures of performance, during which we see conflicting interests and fragmentation emerge.
Last but not least, we will help you understand the role of regulators and the regulation they do concerning the social-technical infra system.

Part C

- *Module 5: Modeling, gaming and simulation*

In the previous modules, you've been introduced to infrastructures, and the complex systems perspective. Now it's time to learn more about **modeling**, which is something people involved in infrastructure systems love to do: think of designers, policymakers and researchers. Modeling has many faces. This week we will show how modeling can help to unravel the complexity of infrastructures. We will introduce different techniques.
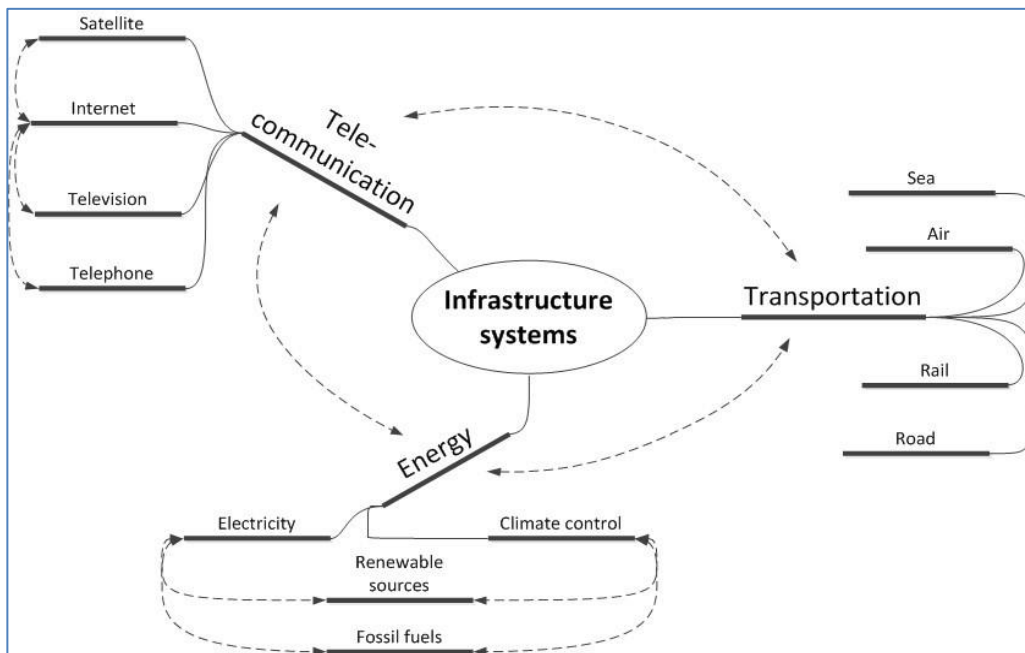
A simple 'modeling' example: a mind map of infrastructure systems

- *Module 6: ICT and infrastructures*

We will look at the role of ICT when it comes to infrastructures. You will learn the basic of designing an architectural framework. Smart grids will be our running example (after we have explained what this means). We will challenge you to develop such a framework for a fair water distribution.

- *Module 7: Exploring new challenges for the future and implications for the design of infrastructures*

In this module, we apply concepts we introduced to cities and the major infrastructural challenges they face (for example, dealing with climate change and the need for resilience, energy transition, congestion, water equality), and we will challenge you to apply your new knowledge.
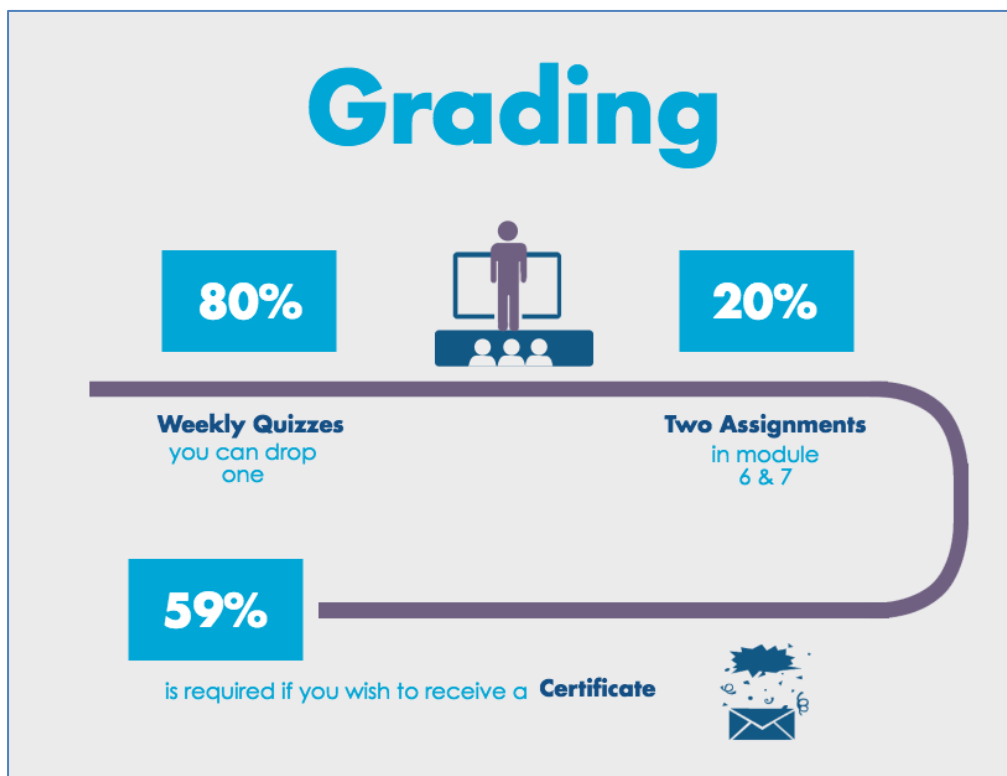
Skills

- *Problem demarcation and actor analysis*
  The last module is all about two essential 21st century skills: problem demarcation and actor analysis. You can start or end with this module but these will be very helpful with the assignments.

In this course, we will talk a lot about complex systems. It might be good to already stress the difference between complex and complicated problems. There is a huge difference between the two:

- Complicated problems or systems are predictable. These systems are often engineered. We can understand these systems by taking them apart and analyzing the details.
- The opposite is true for complex problems or systems. The outcome is unpredictable because of many uncertainties, interconnectedness and inter-dependencies of networks. We have to deal with emergent behavior, non--linearity and social and technical complexity. From a governance perspective, this means a multi--actor game, incremental steps and the need for learning organizations. Complex problems automatically imply that the final answer is not there. It requires a lot of effort to analyze the problems, the actors involved and their interests, and the best way forward. There are always many alternatives and uncertainties. Solutions are very context specific. Infrastructures are complex systems!

In this course we will have 8 quizzes (multiple choice questions; 80% of your total score) at the end of each module and two challenging assignments (module 6 and 7: 20% of your total score). You can drop one quiz. See also the next picture:

Grading

80%
Weekly Quizzes
you can drop one

20%
Two Assignments
in module 6 & 7

59%
is required if you wish to receive a **Certificate**

Role of discussion fora– importance of working together

Working together makes this course all the more easy and all the more fun. Since this course is self- paced, everybody will be working on different steps of the course at the same time. It is up to you to find people to share your learning experience with. You can discuss the analytical techniques, your questions and casework et cetera on edX. Our experience from earlier MOOCs is that most of these collaborations arise from the users who participate actively in the discussion forum. So make sure you make contact with others! Either in the virtual world worldwide, or find people that live or   work close to where you live or work and meet each other to work together!

Honor Code

You have all signed the edX Honor's code. We would like to stress a few issues:

- Please give positive feedback to your fellow students.
- Please report abuse.
- We will respect your privacy. We will not quote individual contributions without your consent.

Forum guidelines can be found here. The course staff will be proactive in removing posts and   responses in the discussion forum that have stepped over the line. Remember that the edX Honor Code applies even outside of www.edx.org. Repeated violations of these guidelines may result in your progress being erased and/or your account being deactivated.