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FOCUS AT THE THREE LOCATIONS

THE CHALLENGE OF CONSTRUCTION MANAGEMENT & ENGINEERING (3TU)

Complex, innovative and multidisciplinary projects in a dynamic environment are calling for a new breed of manager able to competently combine engineering and organisation skills. Today's construction industry is changing fast. New techniques, shifting roles, complex logistics and globalization are only some of the factors affecting the character and management of projects in the building industry.

FOCUS IN DELFT

At TUD, the programme focuses on two aspects: 1) process and system innovation in the building industry in general and 2) the 'Integral Design Concept', which has been developed within the Infrastructure Design and Management section within the Faculty of Civil Engineering and Geosciences. There are six main research areas within this: stakeholder participation, tendering and outsourcing, supply chain integration, value creation, dynamic life cycle support and asset management. Topics that are characteristic of TUD include the Asset management, Project Management and Legal & Finance.

FOCUS IN EINDHOVEN

At TU/e, the specialisation in CME consists of 'Construction Management & Urban Development' (CMUD). The CMUD specialisation is scientifically oriented, focusing on the societal and scientific analysis of real-world problems that involve the combination of two scientific domains: urban development & management and innovation sciences. The CMUD specialisation is strongly related to the research activities of staff members and PhD candidates. Education and research are supported by two major departments: Built Environment, and Industrial Engineering & Innovation Sciences. Courses that are characteristic of TU/e include the following: Urban Research Methods, Technological Entrepreneurship, Entrepreneurial Marketing, Built environment and smart mobility, and Smart Urban Environments.

FOCUS IN TWENTE

At the University of Twente, the 3TU Master's programme in CME focuses on the management of the design and construction process in the construction industry (buildings and infrastructure. Students gain thorough knowledge of both the engineering and organizational aspects of this intricate process. This combination is essential to mastering current practices in complex, innovative and multidisciplinary projects in dynamic environments.

The UT approach centres on the market and organizational environment and the organization of the construction industry and the management of the various stages of the design and building process. Keywords at UT include: cooperation through the entire lifecycle, helicopter view, stakeholder approach and engaged scholarship. The emphasis is on designing, managing and organizing the design and building process. Courses that are characteristic of UT include the following: Markets, Organisation & Innovation, Procurement Strategies and Tendering, Supply Chain Management and ICT and Industrialisation & Innovation in Construction.

ATTENDING COURSES AT AN OTHER LOCATION

You have an automatically side registration at the two other universities that are not your 1st location of registration, so you can register for courses and exams (via electronic learning environment and online exam systems) at another location. That means that each 3TU student receives a letter containing registration information. With this registration information, you can register for courses and exams (via electronic learning environment and online exam systems) at another location.

ATTENDING COURSES AT THE UNIVERSITY OF TWENTE; WHAT TO DO?

1. You should have received a letter from the Central Student Administration (CSA) of the University of Twente with a student number, email address etc. With this data you have access to Blackboard in order to register for courses and Osiris in order to register for exams at the University of Twente.

   If you have not received this information, please mail to p.jansen@utwente.nl. He will organise this information through Central Student Administration for you.
   Are you a TU/e student and would you like to follow courses in Twente, but you don't have received the login details? Please contact stu@tue.nl (Mr. B. Viveen). They will then create new login details for you.

2. Register yourself for the course through Blackboard (https://blackboard.utwente.nl) and register for examinations at Osiris (http://osiris.utwente.nl). More information about Blackboard and Osiris:
   - http://www.utwente.nl/onderwijssystemen/en/about_the_applications/blackboard/
   - http://www.utwente.nl/onderwijssystemen/en/about_the_applications/osiris/
   - http://www.utwente.nl/ces/studentservices/osiris/Osiris/

3. Sign up at the study advisor at the UT ir. J. Krabbenbos (J.Krabbenbos@utwente.nl) for more specific information about studying in Twente.

ATTENDING COURSES AT THE DELFT UNIVERSITY OF TECHNOLOGY; WHAT TO DO?

1. You should have received a letter/mail from the Central Student Administration (CSA) of the University of Delft with a student number, email address etc. With this data you have access to Blackboard in order to register for courses and Osiris in order to register for exams at the University of Delft.

   If you have not received this information, please mail to p.jansen@utwente.nl. He will organise this information through Central Student Administration for you.
   Are you a TU/e student and would you like to follow courses in Delft, but you have not received the login details? Please contact stu@tue.nl (Mr. B. Viveen). They will then create new login details for you

2. Register yourself for the course through Blackboard (https://blackboard.tudelft.nl)

3. Register yourself for the examinations of the course through Osiris (Osiris via Blackboard)

4. Sign up at the study advisor at the TUD, Mr. K.O. Karsen, (k.o.karsen@tudelft.nl) for more specific information about studying in Delft.

ATTENDING COURSES AT THE EINDHOVEN UNIVERSITY OF TECHNOLOGY; WHAT TO DO?

1. You should have received a letter/mail from the Student Service Center of the Eindhoven University of Technology with a student number, email address etc. With this data you have access to Oase in order to register for courses and exams at the Eindhoven University of Technology.

   If you have not received this information, please mail to p.jansen@utwente.nl. He will organise this information through Central Student Administration for you.

2. Register yourself for the course and examinations through Oase (http://education.tue.nl)

Sign up at the study advisor at the TU/e, Mrs. J.A.M.Pulles@tue.nl for more specific information about studying in Eindhoven.

TRANSFERRING ECTS FROM ONE LOCATION (TU) TO ANOTHER

To receive your ECTS at your first University of registration is a manual action!

1. Make sure the course you successfully finished is registered at the location you attended the course including final mark, i.e. in Osiris.
2. Get yourself a certified copy of your marks
   a certified copy is a photocopy with an official stamp and signature to verify that it is a true copy of the original document. You can get a certified copy at the CSA of the TU you attended the course.
3. You hand over the copy to the University of 1st registration. This can be done at the BOZ/Centre for Educational Support of the respective universities. This department will administer the course and grading.

GRADUATION THEMES AT THE THREE LOCATIONS

GRADUATION THEMES IN DELFT

The central theme throughout the different research programmes is about the "process and innovating systems in the construction industry". The thesis mainly focuses on the generic properties of research questions that are of relevance to practical problems. Examples of this are themes such as:

- Stakeholder participation in the construction process
- Forms of tendering and outsourcing
- Transition management
- Financial engineering
- Policy and governance aspects
- Supply chain integration and reversal
- Dynamic life cycle support
- Building Information Modelling (BIM)
- Asset management

GRADUATION THEMES IN EINDHOVEN

At TU/e, the specialization is supported by two major departments: Built Environment, and Industrial Engineering & Innovation Sciences. The input from staff members for graduation projects can be recognized by the distinction of two graduation studios. Participation in one of the two studios is obligatory for all CME students at TU/e:

- Graduation studio I: 'Process engineering for urban development'
  When cities, urban areas or industrial districts are developed or redeveloped complex decision making processes are started in order to bring shareholders and stakeholders together. Negotiation, shareholders' and stakeholders' strategic behaviour, simulation of expected results and process governance are the focus of the graduation projects in this studio.
- Graduation studio II: 'Business engineering for urban development' Within this studio, cities and urban districts are considered and approached in terms of entrepreneurial entities: profit and non-profit companies. In the individual graduation projects, subjects are value features, exploitation possibilities, management and financing concepts.
  For both these two graduation studios relevant societal and engineering topics, regarding smart city development are in focus:
  - Energy management for urban districts
  - Smart cities
  - Implementation of smart mobility concepts
  - Information management

GRADUATION THEMES IN TWENTE

The 3TU Master's programme in CME in Twente uses cutting-edge technology to dissect and understand processes which integrate governance issues, societal trends and management methodologies. CME at the UT has two graduation themes:

- *Markets & Organization in Construction*
  The specialisation Markets & Organisation in Construction focuses on aspects of market dynamics and organisational structures that are typical for the construction industry. Typical characteristics of the construction industry are that it deals with often unique products (no mass-production), with a long planning and production phase, a long life time, constructed in public space, with many involved stakeholders.
- *Design Management in Construction*
  Design Management in Construction focuses on the analysis and management of the design and construction process in the building and construction industry and the coordination of the activities and roles of parties involved.

ORGANISATION OF THE 3TU CME MASTER PROGRAMME

DIRECTORS OF EDUCATION AT THE THREE LOCATIONS

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EXAMINATION COMMITTEES AT THE THREE LOCATIONS

EXAMINATION COMMITTEE IN DELFT

Members of the Examination Committee in Delft:

- Chairman: Dr. R. Schoenmaker
- Member: Drs. M. Leijten
- Member: Mr. F.A.M. Hobma
- Extern member: Drs. K. Taselaar

EXAMINATION COMMITTEE IN EINDHOVEN

Members of the Examination Committee in Eindhoven:

- Chairman: Prof.ir. H.H. Snijder
- Member: Dr. Q.Han (CME)
- Member: Ir. H.J.M. Janssen
- Member: Ir. R.A. Rutgers
- Member: Ir. G.I. Curulli (ABP)
- Member: Dr.ir. A.W.M. van Schijndel (ABP)
- Student counselor: Drs. W.J. Buurke (CME)
- Student counselor: J.H. Steetskamp, Bth (ABP)
- Secretary: Mrs. G.L.C. Bruinewoud-Klaessen
  g.l.c.bruinewoud@tue.nl - Tel. 040 247 3298

EXAMINATION COMMITTEE IN TWENTE

Members of the Examination Committee in Twente:

- Chairman: Prof.dr.ir. J.I.M. Halman (Construction Management and Engineering)
- Secretary: Drs. L.A. Woud-van der Graaf
- Member: Dr.ir. D.C.M. Augustijn (Water Engineering and Management)
- Member: Prof.dr.ir. E.C. van Berkum (Centre of Transport Studies)
- Member: Dr. G.A.M. Jeurnink (faculty EWI, department AAMP)
- Register: Drs. E Ruijgh

EDUCATION COMMITTEES AT THE THREE LOCATIONS

EDUCATION COMMITTEE IN DELFT

Members of the Education Committee in Delft:

- Chairman: Prof.dr.ir. M.J.C.M. Hertogh
- Member: Dr.ir. M.G.C. Bosch-Rekveldt
- Student member: B. Düzgun
- Secretary: M.H. van Vollenhoven-Geldof

EDUCATION COMMITTEE IN EINDHOVEN

Members of the Education Committee in Eindhoven:

- Chairman: Dr.ir. A.D.A.M. Kemperman
- Member: Dr. Q. Han (CME)
- Member: Ir. C.C.J.M. Hak
- Member: Ir.ing. F.J.M. Luijten (ABP)
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- Chairman: Prof.dr.ir. K.T. Geurs
- Member: Dr.mr.ir. M. van Buiten
- Member: Dr.ir. R.S. de Graaf
- Member: Dr.ir. P.C. Roos
- Member: Dr.ir. M.J. Booij
- Student member: D.E.C. Blomjous
- Student member: R.J. Daggenvoorde
- Student member: J.W. Keizer
- Student member: R.L.T. Oppers
- Advisor: Dr.ir. C.M. Dohmen-Janssen
- Advisor: Drs. L.A. Woud - Van der Graaf
- Secretary: Drs. E. Ruijgh

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Website: www.ofcoursecme.com/

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E-mail: info@cmedispuut.nl
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LinkedIn: www.linkedin.com/groups?gid=126804

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Email: concreet@utwente.nl
Website: http://www.utwente.nl/organisatie/alumni/verenigingen/
LinkedIn: www.linkedin.com/groups?home=&gid=55115

COMPULSORY COURSES AT THE THREE LOCATIONS

The study programme is composed as follows:

a. Core programme (compulsory courses), 28 – 37,5 EC
b. Specialism-related courses, 30 – 45 EC
c. Optional/elective courses, 0 – 25 EC
d. Graduation work, 32 – 40 EC

COMPULSORY CORE COURSES IN DELFT

Course Code	Name	Period	Responsible lecturer	EC
AR8002	Legal & Governance	1	Mr. F.A.M. Hobma	7
SPM8000	Project Management	3	Drs. M. Leijten	7
SPM8002	Process Management	2	Drs. M. Leijten	7
CME1200	Collaborative Design & Engineering	4	Dr. R. Schoenmaker	7

COMPULSORY COURSES IN EINDHOVEN

Course Code	Name	Period	Responsible lecturer	EC
1CM900	Project Management	2	Dr.ir. R.A.C.M. Broekmeulen	2.5
1ZM65	System Dynamics	1	Dr.ir. B. Walrave	5
7ZM8M0	Collaborative Design	3	Prof.dr.ir. B. de Vries	5
7ZM3M0	Case Study Process Modelling	1	Dr. Q. Han	2.5
7ZM5M0	Process Modelling & Information Management	4	Dr. Q. Han	5
7ZM9M0	Systems Engineering	1	Prof.dr.ir. B. de Vries	2.5
7ZM6M0	Legal & Governance	1	Prof.dr.ir. B. de Vries	7.5

COMPULSORY COURSES IN TWENTE

The composition of the compulsory courses in Twente depends on the chosen profile (Markets and Organization in Construction, or Design Management in Construction)

Markets and Organization in Construction profile

Course Code	Name	Period	Responsible lecturer	EC
201000095	Procurement Strategies and Tendering	3	Drs.ing. J. Boes	7.5
195810100	Markets, organizations and Innovations	2	Prof.dr.ir. A.G. Doree	7.5
195810200	Supply Chain Management and ICT	1	Dr. J.T. Voordijk	7.5
195820500	Infrastructure Management	4	Dr.sc.techn. A. Hartmann	7.5
195820400	Research Methodology and Academic Skills	2	Dr.sc.techn. A. Hartmann	7.5

Design Management in Construction profile

Course Code	Name	Period	Responsible lecturer	EC
201500097	Planning and Process Management	1	Prof.dr.ing. K.T. Geurs	7.5
195800400	Collaborative Design and Engineering	3	Dr.ir. R.S. de Graaf	7.5
201400012	Building Information Modelling and 5D-planning	3	ir. T. Hartmann	7.5
195810310	Industrialization and Innovation in Construction	4	Prof.dr.ir. J.I.M. Halman	7.5
195820400	Research Methodology and Academic Skills	2	Dr.sc.techn. A. Hartmann	7.5

OVERVIEW OF THE COURSES IN DELFT

COMPULSORY CORE COURSES IN DELFT

Legal & Governance	
Responsible lecturer:	Mr. F.A.M. Hobma
Course code:	AR8002
Period:	1
ECTS:	7

Course description:

The course consists of a legal & governance part:

- The legal part is divided into a private and public law part. The public law part concentrates on principles of spatial regulation on national, provincial and municipal level. The private law part concentrates on procurement proceedings, contracting and responsibility and assurance matters in the field of the construction industry.
- The governance part concentrates on describing and analysing markets, hierarchies and networks as governance modes in the construction sector. Special attention is given to the relations between governmental actors and the actors in the construction sector.

Project Management	
Responsible lecturer:	Drs. M. Leijten
Course code:	SPM8000
Period:	3
ECTS:	7

Course description:

This course focuses on the project management of construction projects. Managing projects in this requires strong leadership skills and proficiency in project management knowledge and practice to be able to achieve the project and organizational objectives on time, on budget and to the satisfaction of stakeholders. The course is designed to provide students with scholarly knowledge in the practice of managing construction projects in order to enhance their career options and prepare them to move into management roles by developing their professionalism, versatility and leadership in an environment of constant change.

Collaborative Design & Engineering	
Responsible lecturer:	Dr. R. Schoenmaker
Course code:	CME1200
Period:	4
ECTS:	7

Course description:
Collaborative Design and Engineering deals with processes in which multiple actors work together for a given civil engineering problem, in a complicated environment. In this course students gain understanding of the aspects of Collaborative Design and Engineering by carrying out a design project in collaboration. In this group assignment, students work together in large teams, deal with stakeholders with diverse interests, apply methods and concepts from the various BSc courses for solving the given problem and deal with the challenges of group dynamics.

Process Management	
Responsible lecturer:	Drs. M. Leijten
Course code:	SPM8002
Period:	2
ECTS:	7

Course description:
Complex construction and engineering projects require collaboration between a variety of actors within a complex and dynamic environment. These actors may be related to a project in various ways, each with different interests, resources and attitudes towards a project, being affected by a project and influencing it in different ways and degrees. In order to understand and adequately deal with these characteristics, process management is needed in addition to project management. Building on practical experiences and process management theory, this course aims at providing students with insights, concepts and skills needed to understand the nature of interaction between actors regarding the initiation and development of, and decision making on projects within uncertain and dynamic situations. They will learn to analyse, develop and apply strategies, tools and arrangements that are part of the process management approach, to understand the differences with line and project management and to recognize the conditions for applying process management.

SPECIALISATION COURSES IN DELFT (OBLIGATORY)

Infrastructure Asset Management	
Responsible lecturer:	Dr. R. Schoenmaker
Course code:	CME1210
Period:	2
ECTS:	7

Course description:
The course has two purposes. The first purpose is to learn to integrate newly acquired and previously acquired methods, techniques, aspects and tools for solving problems and decision-making in an asset management context. The second purpose is to learn to orientate on problems in asset management context by critically looking at these problems from various viewpoints. This course will built on the different backgrounds of the students, coming from various faculties, universities and/or countries.

Dynamic Control of Projects	
Responsible lecturer:	M.G.C. Bosch-Rekveldt
Course code:	CME2200
Period:	4
ECTS:	4

Course description:
Each project is an intervention in an existing situation. The aim is to incorporate a system into an existing environment. A project is a specific and unique development, for a unique client, on a unique location, with a unique goal, to solve a unique problem, with a unique problem solver, etc. A project needs time for the development with a number of subsequent phases: design, engineering, production, etc.
The only way to develop systems which are: fit for purpose, up to date and provided with state of the art technology is that we work dynamically, not only: with the ideas of today, with today's technology and for today's people, but at the same time with the ideas of tomorrow, with the technology of tomorrow, for the people of tomorrow.
This means that we should not only work dynamically in an adaptive way with continuous change, but also that the systems we deliver are also adaptable to changing circumstances. Inevitably, the traditional project management should realize that the construction world will also be a part of the new short-cyclic and circular economy. We need a dynamic control approach.

Probabilistic Design	
Responsible lecturer:	Dr.ir. O. Morales Napoles
Course code:	CIE4130
Period:	2
ECTS:	4

Course description:
After the course, the student has to be able to do Level I, II and III calculations, risk-based optimisations and system probability calculations.

Financial Engineering	
Responsible lecturer:	Ir.drs. J.G. Verlaan
Course code:	CME2300
Period:	1
ECTS:	4

Course description:
This course deals with the finance issues related to the implementation of civil engineering projects. It introduces economic engineering concepts and finance-related topics such as project financing and financial accounting. This course requires the student to study in detail:

- Finance and the firm, covering topics such as sources of finance, cost of finance, financial structures, working capital management and financial accounting
- Capital Budgeting Decisions and Risk, covering topics such as Capital Budgeting, Political and Social factors, Portfolio Management and Risk Considerations
- Project finance, covering topics such as international capital markets, stakeholder/actors viewpoints and cash flow modelling of projects, open mining, infrastructure and office buildings

Methodology for Scientific Research	
Responsible lecturer:	Prof.dr.ir. H.E.J.G. Schlangen
Course code:	CIE4030
Period:	4
ECTS:	3

Course description:
This course is intended for students that would like to 'Design a Research Project". It is also a perfect preparation for the final project in the MSc. The topics that will be presented in this course are: Defining research objectives, Setting up a research framework, Formulating research questions, Different research concepts and strategies, Various research material, Planning your research, Analysing your research results, and Reporting and presenting your research.

Cross-cultural Management	
Responsible lecturer:	Dr. W.M. de Jong
Course code:	EPA1432
Period:	1
ECTS:	5

Course description:
This course is about dealing with cultural differences personally and organisationally. You will learn about how and how much globalisation affects cultures and our understanding of it. You will learn about social-scientific methods (mostly quantitative) for researching and understanding cultures. And you will learn about how one can deal with cultural differences one-on-one, when designing organisations, and when transplanting institutions from one cultural context to another.

Philosophy, Technology Assessment and Ethics	
Responsible lecturer:	Dr.ir. N. Doorn
Course code:	WM0312CIE
Period:	4
ECTS:	4

Course description:
This is a course that provides the student more knowledge on philosophy and ethics within the construction world. The course contains a Philosophy module for questions like 'What is science, and what is technology?', an Ethics module for questions like 'Why does technology fail?' and a Technology Assessment Module for analysing and discussing moral dilemmas in engineering practice and their backgrounds.

ELECTIVE COURSES IN DELFT

Real Estate Valuation	
Responsible lecturer:	Dr.ir. R. Binnekamp
Course code:	AR0880
Period:	1
ECTS:	7

Course description:
The objective of the course is to make students familiar with the background and methods that can be used for appraising Real Estate. State of the art analytical methods to interpret valuation issues are addressed, whereby special attention is given to the valuation of properties under the current market conditions with high vacancy rates, decreasing operating income and few reference transactions for comparison.
This course aims to provide theoretical background information and practical experience with real estate valuation and corporate finance. Different valuation methods and complex finance issues are discussed.

Policy Analysis of Multi-Actor Systems	
Responsible lecturer:	Dr.ir. B. Enserink
Course code:	EPA1123
Period:	3
ECTS:	5

Course description:
In this course students learn how to deal with complex problems in multi-stakeholder environments. They learn about the role of policy analysts in politicized situations; about policy styles, and how to formulate a policy analysis research proposal. Attention will be paid to the design and organisation of policy analysis research, to argumentation, problem framing and the role of information in policy processes.

Open Design and Construction Management – An Operations Research Approach	
Responsible lecturer:	Ir.drs. J.G. Verlaan
Course code:	CME2210
Period:	3
ECTS:	4

Course description:
This elective course is about a managerial approach for complex construction projects focussed at quality in the sense of fitness for purpose, rather than on compliance with specifications, rules and regulations. Since this stakeholder-oriented project management brings along openness and transparency, it is labelled Open Design.
The course comprises four main topics: 1. The stakeholder-oriented mindset; 2. Quality as fitness for purpose; 3. Probabilistic network planning with allowance for mitigations-on-the-run, including associated supporting software; 4. Multi-criteria decision-making, including associated supporting software.

Forms of Collaboration in Civil Engineering	
Responsible lecturer:	Prof.dr.ir. M.J.C.M. Hertogh
Course code:	CIE5981
Period:	1
ECTS:	4

Course description:
In this course a review is given of the most common forms of collaboration in realising a project in civil engineering. The course aims at preparing students fundamentally for the various forms of collaboration he will engage during his professional career. However it is emphasized that no attention will be paid to the literal contents of the various contracts. It is a matter of insight so that later on the correct choices can be made for the adequate form of contract for a specific type of project.

Economics of Infrastructures	
Responsible lecturer:	Prof.dr. R.W. Kunneke
Course code:	EPA1233
Period:	3
ECTS:	5

Course description:
The allocation of infrastructure goods and services is often associated with different kinds of market failures, making governmental intervention often necessary. An interdisciplinary approach is necessary to cope with the complex technical, political and economic dimensions of infrastructures.
The goal of the Economics of Infrastructures course is to give an introduction into economic theories, providing insights into various aspects of the economic allocation, sectorial organization and public management of different infrastructures including transport, ICT and energy.

Strategic Management of Large Engineering Projects	
Responsible lecturer:	H.K. Lukosch
Course code:	SPM4416
Period:	3,4
ECTS:	6

Course description:
The focus of the course is on managing complex technological projects. Attention is given to the role of planning, budgeting and design, steering in a situation of asymmetric information and external legitimating. A distinction is made between project management and process management.
The course is split up into three parts, first introducing the role of project management in large engineering projects, second reintroducing process management and its role in these projects, and finally a focus on the integration of both perspectives.

Designing Multi-actor systems	
Responsible lecturer:	Dr. S.G. Lukosch
Course code:	SPM4110
Period:	1
ECTS:	6

Course description:
In this course, students learn about designing complex, technological, large scale systems in multi-actor environments (in short, multi-actor systems). Different perspectives on systems design are discussed to provide students with a background for working with designers from different disciplines. Various aspects and principles of designing multi-actor systems are discussed from an engineering and a process perspective. Methods and tools for analysis and design of systems are introduced to teach students specific skills for the design of multi-actor systems.

Network and Fleet Planning	
Responsible lecturer:	Prof.dr. R. Curran Dr.ir. B.F. Lopes dos Santos
Course code:	AE4451
Period:	4
ECTS:	3

Course description:
The aim of this course is to introduce students to the most common strategic and tactical airline problems and to discuss some of the analytical approaches that can be used to tackle these problems. The course compromises the study of operations research techniques and other general modelling techniques.

Real Estate Management	
Responsible lecturer:	M. Arkesteijn
Course code:	AR1R025
Period:	2
ECTS:	7

Course description:
The main objective of the Real Estate Management course is to align a particular corporation's or public authorities' real estate portfolio to the needs of the core business (processes) in order to obtain added value for the businesses and to contribute to the overall performance of the corporation, now and in the future. The real estate portfolio has to match both organisation's short and long-term objectives as well as the short and long term altering space demands of users. In the Real Estate Management and Development course you will learn how to design an accommodation strategy from the owner-occupier's perspective.

Materials and Ecological Engineering	
Responsible lecturer:	Dr. H.M. Jonkers
Course code:	CIE4100
Period:	3
ECTS:	4

Course description:
Sustainability concepts in relation to civil engineering activities are treated and discussed. Prime focus lies on 1) recent technological developments and application of sustainable (bio based) processes which enable substantial reduction of harmful emissions and use of finite raw materials of civil engineering practices, and 2) Quantification of sustainability using Life Cycle Assessment (LCA) techniques.

Construction Technology of Civil Engineering Structures	
Responsible lecturer:	Prof.ir. A.Q.C. van der Horst
Course code:	CIE4170
Period:	2
ECTS:	4

Course description:
Understanding the nature and implication of selected structural design aspects such as shape, dimensions, material and design approaches on the one hand and the construction considerations such as execution methods, schedules and costs on the other hand and their interdependency in an integrated building process of a concrete structure. This involves thorough knowledge and understanding of project characteristics, control systems, methodology of the process and supporting systems in order to optimise cost driver aspects in conceptual and final design. Amongst others, topics during the lectures are construction technology from a process prospective, Tender phase of design, The added value and weakness of serviceability Limit State Design, formwork, and handling of concrete at site.

Agent Based Modeling of complex energy and industrial networks	
Responsible lecturer:	Dr.ir. I. Nikolic
Course code:	SPM4530
Period:	1
ECTS:	4

Course description:
Our human society consists of many intertwined Large Scale Socio-Technical Systems (LSSTS), such as infrastructures, industrial networks, the financial and legal systems etc. LSSTS and the ecosystems that they are embedded in are known to be Complex Adaptive Systems (CAS). Understanding Complex Adaptive Systems requires tools that themselves are complex to create and understand. This course will explore the theory of Complex Adaptive Systems (CAS) and their main properties. It will also teach you how to work with Agent Based Models in order to model and understand CAS. The follow up to this course is the Advanced course; part of the Simulation and Gaming Master class (SPM9555) will be a project to set up a model of a CAS you choose independently.

Advanced System Dynamics	
Responsible lecturer:	Dr. J.H. Slinger
Course code:	SPM9155
Period:	2
ECTS:	4

Course description:
The course comprises the following topics: Why System Dynamics, use of data, model behavioural analysis, validation under uncertainty, group model building, exploratory model analysis and games in SD. The theory underpinning these topics will be applied in a number of assignments related to a case which runs in parallel to the lecture series.

Integrated Plant Management	
Responsible lecturer:	Dr.ir. Z. Lukszo
Course code:	SPM9537
Period:	2
ECTS:	5

Course description:
This course is to be recommended for students interested in operational management of an industrial plant, e.g. in food, (fine) chemical, pharmaceutical and metallurgical industry. The integration of the enterprise functions as strategic and tactical management, forecasting, planning, scheduling, optimisation and control are the central theme of the course. Next, the course introduces Lean Six Sigma approach for quality and waste management.

Safety of Transportation	
Responsible lecturer:	Prof.dr.ir. J.A.A.M. Stoop
Course code:	AE4456
Period:	1
ECTS:	3

Course description:
The course deals with the structure and development of the notions of safety and risk management by focusing on Practice, Control, Technology, a micro systems level, the meso systems level, the macro systems level, Safety Cases and Critical Size Events, Rescue and emergency management and disaster control in the light of national and international perspectives such as EU Directives and international NGO's. This course provides the student a basic knowledge in safety from a systems perspective.

Project Finance	
Responsible lecturer:	Ir. drs. J.G. Verlaan
Course code:	CIE4020
Period:	3
ECTS:	4

Course description:
For a variety of reasons, infrastructure and industrial projects are increasingly set up to be "self-financing" (meaning that the financing is arranged by, and through, the project itself and not by the organisation commissioning it). This specific field is called Project Finance. The aim of the course is to prepare students for this development. The course aims to be both theoretically sound and practical, in part by using real life case studies to illustrate the themes, and through assignments to give students first-hand experience in what it takes to put together a financeable project.

Information Systems for Infrastructures and Buildings	
Responsible lecturer:	Dr.ir. G.A. van Nederveen
Course code:	CIE4120
Period:	1
ECTS:	4

Course description:
This course contains Information theory, BIM concepts: Parametric Design and Interoperability, Life Cycle Information Systems concepts: network approach, asset and maintenance information management, and Role and importance of BIM and Life Cycle Information Systems in Construction Projects and Organizations.

Integral Design and Management	
Responsible lecturer:	Prof.dr.ir. A.R.M. Wolfert
Course code:	CIE4480
Period:	4
ECTS:	4

Course description:
This course provides an introduction of systems analysis, design and development and its application in areas such as civil infrastructure engineering, offshore engineering, hydraulic engineering and building engineering. Subjects are: basic concepts, system analysis, system specification, system development, decision support systems, and verification and validation. For every subject a theoretical introduction is combined with a discussion on application in engineering projects.

Assessment of Transport Infrastructure and Systems	
Responsible lecturer:	Dr. D. Milakis
Course code:	CIE4760
Period:	2
ECTS:	6

Course description:
Topics during this course are amongst others Cost benefit analysis, Multicriteria analysis and other assessment method, Economic and financial assessment, Environmental assessment,
Social assessment, Usage of assessment results in planning process, debate and criticisms on assessment methods and case studies, for example in the field of Transport infrastructure (e.g. road infrastructures; new and/or renewal), transport systems (e.g. public transport systems; intelligent transport systems; requiring investments yet no (substantial) traditional infrastructure).

Continuous Systems Modelling	
Responsible lecturer:	Dr. E. Pruyt
Course code:	EPA1322
Period:	1
ECTS:	5

Course description:
This course introduces the System Dynamics method for modelling dynamic systems. The theory is discussed according to the modelling cycle: conceptualisation, specification, validation and use of System Dynamics models. The module consists of a theoretical/practice part and a part in which students have to carry out a modelling project.

Infrastructure Management	
Responsible lecturer:	Prof.dr.ir. A.R.M. Wolfert
Course code:	CIE3380
Period:	3
ECTS:	4

Course description:
This course gives a first understanding of the methods, processes and tools which play a conditional role within management of civil engineering infrastructure networks (e.g. high-, water- or railways and offshore marine): a joint effort of the infra owner (client/principal) and the services provider (contractor). The type of the contract between the owner (OG) and the services provider (ON) is the DBFM construction. Risk control and the supporting processes during the design, build and maintain phase of the engineering assets are key within this course.

Uncertainty and sensitivity Analysis	
Responsible lecturer:	D. Kurowicka, Dr.ir. O. Morales Napoles
Course code:	WI4050
Period:	3,4
ECTS:	6

Course description:
This course contains the basic tools for uncertainty analysis; Dependence modelling: representation of a joint distribution with given margins and given rank correlation structure; Probabilistic sensitivity measures: screening techniques, global and local sensitivity measures; Techniques for probabilistic inversion

Decision theory/expert judgement	
Responsible lecturer:	G.F. Nane
Course code:	WI4138
Period:	1,2
ECTS:	6

Course description:
Representation of uncertainty as rational preference, subjective probability, utility, Savage's representation theorem, exchangeability, De Finetti's theorem, value of information, expert judgment, scoring rules, paired comparisons, classical / Bayesian models, applications. Study goals are acquiring an in-depth understanding of rational decision theory and the mathematical foundations for the use of expert opinion in science; to become capable of conducting a structured expert judgment elicitation and summarizing the findings in a concise and accessible report.

Data Visualization	
Responsible lecturer:	Prof.dr. E. Eisemann
Course code:	IN4086
Period:	2
ECTS:	6

Course description:
Data visualization is the visual representation of large quantities of data by computer generated images. In this course, techniques and cases of data visualization are discussed: models, algorithms, and data representations for conversion of data sets into visual images, and associated interactive techniques.
After the course, the student has knowledge and understanding of a wide range of general visualization techniques, their mathematical foundations, their algorithmic form, and relevant data representations, so that (s)he can choose, adapt, and develop suitable techniques for a given practical visualization problem.

3D Computer Graphics and Animation	
Responsible lecturer:	Prof.dr. E. Eisemann
Course code:	IN4152
Period:	3,4
ECTS:	5

Course description:
In this course, students will get a good idea of Computer Graphics in general. The topic is of very high relevance for the industry and the research community and has numerous applications in different domains, such as scientific visualization, video games, simulators, special effects, animated movies and many more.
Here, students will learn about basic algorithms, as well as modern techniques.

Discrete Systems Modelling	
Responsible lecturer:	Prof.dr.ir. A. Verbraeck
Course code:	EPA1332
Period:	3,4
ECTS:	5

Course description:
The goal is to understand the theory of discrete modelling and simulation and its application to practical situations in domains such as logistics, manufacturing and infrastructures. The course covers Theory of discrete event systems, Probability distributions and statistical tests, Queuing Systems, Conceptual modelling, Model Specification, Verification and validation, Experimental design, Introduction to Simio Simulation Software, and Practical application of the knowledge and skills on a real-life problem.

Cost-Benefit-Analysis: Theory and Applications	
Responsible lecturer:	Dr.ir. Z. Roosenboom-Kwee
Course code:	SPM9716
Period:	1
ECTS:	4

Course description:
The application of Cost-Benefit Analysis is fraught with has difficulties and limitations that need to be taken into account. What rates of interest are appropriate for determination of present and future costs and benefits of a policy proposal? Why and how do the private benefits and costs of a policy proposal differ from the social benefits and costs? How can we express e.g. environmental damage, or human health and life risks, in money units?
Such questions are addressed with the help of a variety of case-studies, including climate stabilization policy, large infrastructure projects or large events such as the Olympic Games.

Intermediate Economics	
Responsible lecturer:	Dr. C.W.M. Naastepad
Course code:	SPM9715
Period:	1
ECTS:	5

Course description:
The course analyses macro-economic policy, monetary policy, financial-sector policy, European integration, debts and deficits, and the process of money creation. Special attention will be given to global imbalances and domestic and causes of (and solutions to) the Eurozone crisis.

Legal Aspects of Multi Actor Systems Design	
Responsible lecturer:	N. Saanen
Course code:	SPM4423
Period:	3
ECTS:	5

Course description:
At the end of the course the student will be able to read and understand legal documents, point out relevant legal aspects when designing or assessing a project, carry out a basic check on the compatibility of a project with relevant law, give an alternative design of a project in order to overcome legal problems.

Environmental Sustainability in the Built Environment	
Responsible lecturer:	Dr. L.C.M. Itard
Course code:	SPM9750
Period:	1
ECTS:	4

Course description:
The course is aimed at students, who want to deepen their knowledge of sustainable buildings (zero-energy buildings) and the processes involved in their development. It is based on a system modelling approach, in which the relationship between energy needs and energy conversion, environmental impacts and health impacts, life cycle costing and process management are treated.

Smart Infrastructure and Mobility	
Responsible lecturer:	R.C. Rocco de Campos Pereira, Prof.dr.ir. A. van Timmeren
Course code:	AR0027
Period:	4
ECTS:	6

Course description:
The main goal of the course is to elaborate a critical analysis of metropolitan mobility issues in relation to issues of planning and the natural and man-made landscape.
The aim is to understand and act on aspects of metropolitan mobility, water management and urban design in a developing context, through research and the elaboration of a spatial design for a sub-system of the High Tietê river basin system in São Paulo, Brazil.

Internship	
Responsible lecturer:	M.G.C. Bosch-Rekveldt
Course code:	CME2100
Period:	1,2,3,4
ECTS:	10

Course description:
Practical work experience in day-to-day practice of civil engineering companies or institutes (contractors, consultancies, government, non-governmental organisations, etc.) in the Netherlands or abroad. The major part of the practical work is dedicated to an individual (research) assignment, to be agreed upon with the internship coordinator.

Multidisciplinary Project	
Responsible lecturer:	Y. de las Heras
Course code:	CIE4061
Period:	1
ECTS:	10

Course description:
During this project, students solve an actual and recent civil engineering problem in a multidisciplinary team. Integrate several studies and designs into a coherent entity, based on knowledge, understanding and skills acquired in the preceding years. Attention will be on quality control and the evaluation of the design process. Knowledge and skills obtained during the BSc projects will be used in this project.

GRADUATION IN DELFT

Master Thesis Preparation	
Responsible lecturer:	Ir.drs. J.G. Verlaan
Course code:	CME2001
Period:	1, 2, 3, 4
ECTS:	4

Course description:
Preparation for graduation; this involves drawing up a learning plan and completing a preparatory course of study or desk research, which will be recorded in a start report by using a research methodology. Used literature should be listed in a list of references.

Master Thesis	
Responsible lecturer:	Ir.drs. J.G. Verlaan
Course code:	CME2000
Period:	1, 2, 3, 4
ECTS:	32

Course description:
Students have to carry out an individual project to round off the CME programme. The subject for the research project may be chosen in respect to, or independent from, a specific area of technology and possible elective profile, though students are stimulated to find some connectivity in their choices. Within this project, students must demonstrate their capacity for academic analysis, synthesis, design, reflection and written communication on a particular issue in the field of engineering and policy analysis.

OVERVIEW OF THE COURSES IN EINDHOVEN

COMPULSORY COURSES IN EINDHOVEN

PROGRAMME OVERVIEW

	EC	Quartile
Core courses (30 ECTS)		
Project Management	2.5	2
System Dynamics	5	4
Process Modelling and Information Management	5	4
Case Study Process Modelling	2.5	1
Collaborative Design	5	3
Systems Engineering	2.5	1
Legal and Governance	7.5	1
Specialization electives (35 ECTS out of 50 ECTS)		
Urban Research Methods	5	3
Smart Urban Environments	5	2
Fundamentals in BIM	5	2
Technological Entrepreneurship	5	1
Entrepreneurial Marketing	5	2
Built Environment and Smart Mobility	5	4
Research and Development Project	10	1
Big data and experiments for urban analysis	10	3,4
Free Electives course (15ECTS)		
All 3TU-CME MSc-courses offered by TU/e, TUD, UT		
Graduation CME incl. Research proposal (40 ECTS)	**40**	**1,2,3,4**

Case Study Process Modelling	
Responsible lecturer:	Dr. Q. Han
Course code:	7ZM3M0
Period:	1
ECTS:	2.5

Course description:
The course focuses on executing analysis for the process of a complex development project in the context of Construction Management and Engineering.
At first a real complex development project challenge is identified. This projects can be an international well known project, e.g., an Olympic stadium. Students are required to search all the necessary information online and use appropriate methods for analysis. The case study focuses more on the soft side of the process in terms of understanding the nature of interaction between involved stakeholders and decision making on projects within an uncertain and dynamic social, political and physical environment.

Project Management	
Responsible lecturer:	Dr.ir. R.A.C.M. Broekmeulen
Course code:	1CM900
Period:	2
ECTS:	2.5

Course description:

The course comprises the following topics: Planning work activities, costs and budgets, activity scheduling (PERT/CPM), resource allocation, and project execution (information requirements and control).

After the course, students are able to:

- characterize a project aiming at the realization of a physical product in terms of the dynamics, the variability and the stochasticity of the project targets, the activities be performed and their precedence relationships. The available resources and the time cost budget constraints.
- analyse the possible result of a project as function of its targets, its activities and the deployment of resources over time.
- evaluate the possible contribution of advanced decision making methods to improvements in project performance

System Dynamics	
Responsible lecturer:	Dr.ir. B. Walrave
Course code:	1ZM65
Period:	1
ECTS:	5

Course description:

In the first part, the course deals with a variety of subjects related to systems thinking, like: policy resistance, positive and negative feedback, bounded rationality, misperceptions of feedback, fundamental modes of dynamic behaviour (exponential growth, oscillation) and causal loop diagramming. In the second part, the course focuses on system dynamics modelling, by dealing with stocks and flows diagramming, the mathematical relation between stocks and flows (integration and differentiation), delays, modelling human behaviour and modelling supply chains.

Also, students will perform a group assignment in which a system dynamics model is developed based on a case description of business processes. With this model, students will replicate the behaviour of the business processes, understand the causes of this behaviour, and simulate scenarios to improve the performance of these processes.

Systems Engineering	
Responsible lecturer:	Prof.dr.ir. B. de Vries
Course code:	7ZM9M0
Period:	1
ECTS:	2.5

Course description:
Systems Engineering principles are learned in the context of the building sector and by practicing Systems Engineering (SE) and Building Information Modelling (BIM) tools.

At first an introduction is presented on the theoretical principles of Systems Engineering. Following a student will work on assignments with different SE/BIM tools. These tools are state-of-the-art, but not yet well established in the building sector. Finally a report is written containing the output of the assignments and a reflection on how to improve SE in the building sector.

Process Modelling & Information Management	
Responsible lecturer:	Dr. Q. Han
Course code:	7ZM5M0
Period:	4
ECTS:	5

Course description:
During this course, students will learn how to construct mathematic models to model and analyse the problems in the development projects, and optimize the process and manage the information flow. Students learn to understand and apply the analysis method for process modelling and information management in the context of urban development. The course deals with Process management, Process modelling, Agent based models, Qualitative methods, Linear optimization models, Discrete optimization models, Network optimization models and Measuring Stakeholders' Interests and Actions.

Legal & Governance	
Responsible lecturer:	Prof.dr.ir. B. de Vries
Course code:	7ZM6M0
Period:	1
ECTS:	7.5

Course description:
The course consists of a legal & governance part:

- The legal part is divided into a private and public law part. The public law part concentrates on principles of spatial regulation on national, provincial and municipal level. The private law part concentrates on procurement proceedings, contracting and responsibility and assurance matters in the field of the construction industry.
- The governance part concentrates on describing and analysing markets, hierarchies and networks as governance modes in the construction sector. Special attention is given to the relations between governmental actors and the actors in the construction sector.

Collaborative Design	
Responsible lecturer:	Prof.dr.ir. B. de Vries
Course code:	7ZM8M0
Period:	3
ECTS:	5

Course description:
The objective of this course is to gain insight in the problem domain of Collaborative Design with special attention to Systems Engineering (SE) and Building Information Models (BIM).

A consortium of companies will work on a design assignment for one semester. A student is member on one of the following companies: Architects, Urban designers, and Engineers. A company consists of 4 persons with one person as Chief Executive Officer (CEO), one Systems Engineering Officer (SEO) and the other two as domain experts. The consortium management consist of all CEOs and SEOs from all companies. CEO and SEO will swap roles with the two other persons halfway the project. The project starts with writing a project management plan. Following the design is created between the companies while monitoring and evaluating the progress. In this process the application of SE and BIM techniques and tools is compulsory. Consortium management is tutored by the teachers in weekly sessions. Finally the design is presented and reports are written about the design product and process.

SPECIALISATION COURSES IN EINDHOVEN

Urban Research Methods	
Responsible lecturer:	Prof.dr. T.A. Arentze
Course code:	7ZW7M0
Period:	3
ECTS:	5

Course description:
In this course students learn core research and evaluation methods for urban planning/management. The focus is on quantitative methods and evaluation techniques. Research methods are relevant in the first stages of the decision process where the aim is to generate knowledge about a problem or possible actions. Evaluation techniques are relevant in the last stage where the aim is to determine a preference ranking of action alternatives. The techniques are explicitly positioned in a decision process model.
The course consists of a series of lectures and literature study. Each lecture is complementary to the literature studied and accompanied by a practical exercise where the students apply the theory to a case.

Technological Entrepreneurship	
Responsible lecturer:	Dr. M.M.A.H. Cloodt
Course code:	1ZM20
Period:	1
ECTS:	5

Course description:

The aim of this course is to develop your awareness, understanding and application of flexible and adaptive decision-making approaches along with more familiar prediction and planning-based methods for decision making in the face of uncertainty in new business development based on new technology.

Throughout this course, students learn to apply flexible and adaptive approaches towards decision making in new business development along with more familiar planning and prediction-based approaches. Using adaptive and flexible approaches, entrepreneurs take small organic steps during their decision making process and apply validated learning approaches as a way to deal with uncertainty. Accordingly, the intellectual content of the course is centered on the notion of "Validated Learning", defined as an iterative learning process of trying out an initial idea, measuring it to validate the effect and incorporating the lessons learned into the succeeding test.

Entrepreneurial Marketing	
Responsible lecturer:	Dr.ing. J.P.M. Wouters
Course code:	1ZM120
Period:	2
ECTS:	5

Course description:

This course:

- Provides knowledge of how to bridge the marketing discipline and the entrepreneurial field
- Provides guidelines and tools to deal with entrepreneurial side of marketing
- Provides guidelines and tools to deal with the marketing side of entrepreneurship

Topics in this course are the introduction to marketing-entrepreneurship interface, the technology adoption life cycle (TALC), and the entrepreneurial marketing plan.

Built Environment and Smart Mobility	
Responsible lecturer:	S. Rasouli
Course code:	7ZW4M0
Period:	4
ECTS:	5

Course description:

This course deals with analysing the interdependencies between transportation and various aspects and components of urban systems. Application of models to support transport-related design and decision processes in urban design, planning, real estate and transportation, considering:

- The complex interdependencies involved
- Effects on the environment, functioning of the system and quality of life
- Uncertainties in model applications, data and scenarios.

Research and Development Project	
Responsible lecturer:	Prof.dr.ir. B. de Vries
Course code:	7ZM1M0
Period:	1
ECTS:	10

Course description:
Executing a Research and Development project for a specific case in the context of Construction Management and Engineering and/or Design Systems. To reach the goal, research and development methods/techniques are selected that are not yet known by the student, but are relevant for the student's education. These methods/techniques are state-of-the-art in DDSS research. Design Systems Lab facilities are available to support experiments. With support from the staff these new methods/techniques are learned by doing. The results are tested against the predefined criteria. Finally a scientific report is written that reflects upon the achieved results.

Smart Urban Environments	
Responsible lecturer:	Prof.dr. T.A. Arentze
Course code:	7ZW5M0
Period:	2
ECTS:	5

Course description:
Cities are booming and constitute the heart of economic and cultural developments. At the same time, threats of the quality of living environments ask for smart solutions in areas such as mobility, health and energy. In this course, new perspectives offered by emerging technologies and research are addressed. The course considers current issues in urban development (smart cities, healthy cities, smart grids) and links these issues to new approaches in urban analysis and decision support (AI, big data).

Project Big Data and Experiments for Urban Analysis	
Responsible lecturer:	Dr.ir. A.D.A.M. Kemperman
Course code:	7ZW1M0
Period:	3,4
ECTS:	10

Course description:
To find good solutions one need to have a good understanding of the problem. This holds true also for the problems urban planners are facing in areas such as mobility (congestion and accessibility), health (air pollution, passive life styles), energy (smart grids and transformation to renewable sources of energy) and ageing (social exclusion, social satisfaction).
In this project students consider a planning problem of their choice and apply an approach to better understand the problem and evaluate scenarios.

Fundamentals of BIM	
Responsible lecturer:	Ing. J. Dijkstra
Course code:	7M900
Period:	2
ECTS:	5

Course description:

During this course, students learn:

- to model with the visual modelling language UML (Unified Modelling Language). UML is used as the "stepping stone" to translate data models created by other diagram techniques. This is important because standards for information exchange play a major role.
- to read and to interpret the models created with different diagram techniques. Topics will be discussed about Express and Express-G diagram technique used to describe IFC classes, XML and XML Schema, GML and CityGML for representing geographic information.
- to read models created with some outdated diagram techniques as a basis for new insights. In addition, up-to-date BIM developments will be discussed.

GRADUATION IN EINDHOVEN

Graduation Project	
Responsible lecturer:	Prof.dr.ir. B. de Vries
Course code:	To be decided
Period:	1,2,3,4
ECTS:	40

Course description:

Part 1: Research proposal

The student will learn how to prepare and how to plan his/her complex final graduation study assignment by writing a research proposal of the individual research based graduation project.

Part 2: Graduation project

At the TU/e the graduation specialization of CME consists of `Construction Management & Urban Development' (CMUD). This final graduation project (that is given in the form of two graduation studios) has a clear profile of scientific signature and has a strong involvement with research activities of staff members and PhD. researchers. CMUD is focused on the societal and scientific analysis of real world problems, in which domains of science interact: science concerning (urban) technical and organizational systems and management and innovation sciences.

During the Graduation Project, the students will learn to make scientific analysis for complex problem situations: problem finding. They will learn to model these problem situations and will learn how to elaborate and to model possible solutions by integrating their knowledge concerning technical systems, urban environment features and management theories. The students will be skilled in domain-specific documentation and presentation of the results of research and design projects.

OVERVIEW OF THE COURSES IN TWENTE

PROGRAMME OVERVIEW

Profile: Markets and Organization in Construction	**Profile: Design Management in Construction**
Compulsory profile courses (37,5 EC)	**Compulsory profile courses (37,5 EC)**
- Procurement Strategies and Tendering - Markets, organizations and Innovations - Supply Chain Management and ICT - Infrastructure Management - Research Methodology and Academic Skills	- Planning and Process Management - Collaborative Design and Engineering - Building Information Modelling and 5D-planning - Industrialization and Innovation in Construction - Research Methodology and Academic Skills
Elective profile courses (30 EC)	**Elective profile courses (30 EC)**
- Planning and Process Management - Project Management - Project Control and Risk Management - Building Information Modelling and 5D-planning - Collaborative Design and Engineering - Industrialization and Innovation in Construction - Sustainable Building - Geo Risk Management - CME-courses TU/e and TUD	- Sustainable Building - Geo Risk Management - Project Management - Project Control and Risk Management - Supply Chain Management and ICT - Infrastructure Management - Procurement Strategies and Tendering - Markets, organizations and Innovations - CME-courses TU/e and TUD
Electives (maximum 15 EC) - All courses offered by the department of Civil Engineering - Profile Electives - Max 7,5 EC can be chosen freely from all the MSc-courses offered by the University of Twente (or any other university)T	
Thesis (37,5 EC) - Preparation MSc-thesis (7,5 EC) - MSc-Thesis Project (30 EC)	

Compulsory course in the Markets and Organization in Construction profile

Markets, Organizations & Innovation	
Responsible lecturer:	Prof.dr.ir. A.G. Doree
Course code:	195810100
Period:	2
ECTS:	7,5

Course description:
The course focuses on the issue of changes in procurement, and the effects on organization strategies and innovation. It explains the relationships between market regulation, competition, market dynamics and innovation in the building sector at the level of the sector and the company. It also addresses the issue of business paradigms and strategic management for firms in the construction industry.

Procurement Strategies & Tendering	
Responsible lecturer:	Drs.ir. J. Boes
Course code:	201000095
Period:	3
ECTS:	7,5

Course description:
This course focuses on an important trend in the Dutch construction industry: the increased use of integrated procurement routes by clients, in particular by large public clients like Rijkswaterstaat, Prorail and Rijksgebouwendienst. Besides choosing a procurement route that fits your situation, you also need to choose a tendering procedure that fits the procurement route you chose. The availability of a variety of procurement routes brings in a new dilemma for clients. Imagine clients who are in need of a new road, bridge of building. What procurement route should be chosen for the specific construction project? And for what reasons? But this is not the only dilemma. Besides choosing a procurement route that fits to the situation, students also need to choose a tendering procedure that fits the procurement route you chose. Reality shows us this isn't an easy task. The goal of this course is to teach you to tackle these dilemmas.

Supply Chain Management & ICT	
Responsible lecturer:	Dr. J.T. Voordijk
Course code:	195810200
Period:	1
ECTS:	7,5

Course description:
The focus is on the opportunities for the application of supply chain and purchasing management concepts from other industries to construction for the improvement of construction supply chain management and materials transport and distribution between manufacturers and construction sites. Basic similarities and differences between supply chains in the construction industry and supply chains in manufacturing industries are analysed.
The focus is on supply chain and purchasing management issues in the relation between construction firms and their suppliers. Attention will be devoted to the role of building information modelling in improving construction supply chain management.

Infrastructure Management	
Responsible lecturer:	Dr. A. Hartmann
Course code:	195820500
Period:	4
ECTS:	7,5

Course description:
The focus of this course is on the management of infrastructure facilities and the maintenance and rehabilitation process in particular. The course provides the basic concepts and tools to procure and preserve infrastructure systems most cost-effectively. It shows how to prevent costly deterioration of infrastructure and to ensure an acceptable performance level of the infrastructural asset.

Research Methodology & Academic Skills	
Responsible lecturer:	Dr. A. Hartmann,
Course code:	195820400
Period:	2
ECTS:	7,5

Course description:
The main aim of the course is to prepare the students for tasks/jobs where (research) reports need to be assessed or produced (in a wider sense). It is all about arguments, data, theory and proof, requires skills and competences in reasoning, research, data gathering, analysis and formulation of problems and account of results.

Compulsory in the Design Management in Construction profile

Planning & Process Management	
Responsible lecturer:	Prof.dr.ing. K.T. Geurs
Course code:	201500097
Period:	1
ECTS:	7,5

Course description:
This course focuses on (transport) infrastructure planning and process management of major infrastructure projects and area developments. Current developments in cities realities force authorities to plan, manage and monitor their transport and infrastructure systems more accurately, for example to take into account the requirements of a growing number of complex and sometimes conflicting interests like congestion relief, pollution reduction, efficient resource use, equity and accessibility.
This course has two main elements:

1. Strategic Transport Infrastructure Planning: students review and discuss the strengths, limitations and weaknesses of state of the practice strategic transport policy and transport planning frameworks.
2. Project and Process Management: students analyse, develop and apply strategies, tools and arrangements that are part of the process management approach to understand the dynamics of multi-actor interaction processes in uncertain and highly politicized contexts.

Collaborative Design & Engineering	
Responsible lecturer:	**Dr.ir. R.S. de Graaf**
Course code:	195800400
Period:	3
ECTS:	7,5

Course description:
The course deals with the social aspects of design and engineering processes as well as the technical and organizational aspects. Theoretical aspects of communication and management in collaborative design and engineering are introduced with a focus on the following research areas:

- collaborative design approaches
- multidisciplinary team design
- management of collaboration

Collaborative design approaches are best learned by and be confronted with the results. Therefore this course is built around a role-play project and interactive workshops. In the role-play project students can only 'solve' the project by interacting with a variety of stakeholders represented by the lecturer. Workshops will teach in an interactive manner the skills and competencies students need for the course-project.

Building Information Modelling and 5D Planning	
Responsible lecturer:	Ir. T. Hartmann
Course code:	201400012
Period:	3
ECTS:	7,5

Course description:
The main objective of the course is to explore current technological possibilities to integrate project management data with state of the art information technologies. This exploration will help students to understand non-technological related problems of integrated project management and its relation to overall project costs. Due to the exploratory character of the class students will learn to use new technologies within a practical learning by doing context.

Industrialization & Innovation in Construction	
Responsible lecturer:	Prof.dr.ir. J.I.M. Halman
Course code:	195810310
Period:	4
ECTS:	7,5

Course description:
The building industry is currently looking for innovative ways to increase the influence of customers on the design of their own buildings without increasing the price to a level not accepted by target customers and by also maintaining the advantages of serial project-wise production. The course addresses the following three themes:
- industrialization and innovation processes in general and in construction in specific
- mass customization versus tailor made solutions in general and in construction in specific
- new to be expected developments in industrialization and innovation in construction

See page 40 for the description of the course Research Methodology & Academic Skills

Elective profile courses profile

Profile Markets & Organization in Construction

See "Compulsory profile Design Management in Construction" for the course descriptions of the courses Planning & Process Management, Collaborative Design & Engineering, Building Information & 5D-planning, and Industrialization & Innovation in Construction.

Profile Design Management in Construction

See "Compulsory profile Markets & Organization in Construction" for the course descriptions of the courses Procurements Strategies & Tendering, Markets, Organizations & Innovations, Supply Chain Management & ICT, and Infrastructure Management.

Other elective profile courses:

Project Management	
Responsible lecturer:	**dr. S.H.S. Al-Jibouri**
Course code:	195800200
Period:	2
ECTS:	7,5

Course description:
This course provides students the theoretical necessary knowledge to understand how projects can be effectively and efficiently managed. Assembling the proper team, defining the project scope, managing priorities and controlling the process are essential elements to achieving project objectives. The course provide insight into the different roles of a project (team), the project processes & dynamics. Practical information of project management is provided by lectures, assignment, excursions, reports and DVD's, mainly focusing on large construction projects and the dynamics of the process.
Upon successful completion of this course, students should be able to understand 1) how projects are organised, 2) the different roles and interests in a project, 3) various project management skills, competencies & tasks, 4) the dynamics of the process, and 5) the trades off/balance between safety, costs, time, scope and quality in projects.

Sustainable building	
Responsible lecturer:	Dr.ir. A.G. Entrop
Course code:	195810400
Period:	1
ECTS:	7,5

Course description:
In this course you will learn how to work with the moveable target, which sustainable building is. Many techniques will be introduced to the student to lower the environmental impact of buildings. You will be though how to choose between all these techniques and measures and how to incorporate them in building processes. The content of the course is based on three pillars, namely sustainable building process management, sustainable building technology and sustainable building physics. Multiple forms of education are used to learn the basics of sustainable building.

Project control & Risk Management	
Responsible lecturer:	Dr. S.H.S. Al-Jibouri
Course code:	195810600
Period:	3
ECTS:	7,5

Course description:

Construction is project-based and project development usually involves numerous parties, various processes, different phases and stages of work and a great deal of input from many public and private stakeholders. By nature it is also inherently fragmented, complex and risky industry. The combination of these factors has created some serious problems for the efficiency with which the construction industry operates compared to other sectors. As a result of this too many projects fail to achieve their objectives within the original budget and time or able to satisfy their customers and are considered by many from within or outside the industry as failures.
The course aims at teaching students:

- techniques to control project plans; the focus is primarily on the construction phase
- time and cost trade-offs
- the need, objective and value of risk management
- development of risk management strategy and use of tools for identifying and analysing risks in construction

Geo Risk Management	
Responsible lecturer:	Dr.ir. U.F.A. Karim
Course code:	195820300
Period:	3
ECTS:	7,5

Course description:

The objective of this course on GRM is to provide the students an understanding of the basics and applications of this complex and still developing subject. This is achieved through studying a topics and numerical tools, with emphasis on (Civil Engineering) applications to some basic problems selected from geomechanics and geostatistics.
The main emphasis of the course is applications of a well-tested Georisk Assessment (GRA) tool (RFEM: random finite element method) to basic problems from soil mechanics for which deterministic analytical, empirical or approximate solutions are available. This to demonstrate and grasp the use of the technique for solving simple problems before being able to apply this or other techniques for tackling more complex problems.

FREE ELECTIVE COURSES IN TWENTE (<15 EC)

Legal & Governance Aspects	
Responsible lecturer:	dr. P.J. Klok
Course code:	195800100
Period:	1
ECTS:	7,5

Course description:
This course is about legal & governance aspects of the construction process, especially the institutional legal & framework settings concerning the major players and the main interests concerned. The main course topics will deal with both public and private law. The place and position of the future graduate in the construction process will serve as a guideline in the selection of these topics.

The course consist of a legal & governance part. The legal part is divided into a private and public law part. The public law part concentrates on principles of spatial regulation on national, provincial and municipal level. The private law part concentrates on procurement proceedings, contracting and responsibility and assurance matters in the field of the construction industry.
The governance part concentrates on describing and analysing markets, hierarchies and networks as governance modes in the construction sector. Special attention is given to the relations between governmental actors and the actors in the construction sector.

Sustainable Transport	
Responsible lecturer:	Prof.dr.ing. K.T. Geurs
Course code:	195420800
Period:	4
ECTS:	7,5

Course description:
This course discusses (1) problems and solutions of sustainability in the (urban) transport sector in a national and international context; (2) scientific methods and techniques for applying sustainable development theory in the planning and assessment of sustainable transport systems and; (3) specific topics and dilemmas in sustainable transport theory and practice.

Traffic Management	
Responsible lecturer:	Prof.dr.ir. E.C. van Berkum
Course code:	201100006
Period:	4
ECTS:	7,5

Course description:
This course is about traffic modelling and traffic management. Topics: concept of regional traffic monitoring, qualities of the transport system, traffic control and its properties, important measures as Ramp Metering, Motorway Traffic Management system and Traffic Information and Pricing measures and a framework on how to design a regional traffic management plan.
This course further contains an assignment where students design, implement and evaluate a traffic management system in a simulated environment.

Public Transport	
Responsible lecturer:	Ir. K.M. van Zuilekom
Course code:	195421200
Period:	1
ECTS:	7,5

Course description:
This course is about public transport as a transport system matching the demand for transportation. Included in this course are topic related to the demand for public transport (spatial impact of public transport, data collection, demand modeling, price elasticity), the supply side of public transport (the organization of public transport, time tables, legal issues [Wet Personenvervoer], overview of public transport systems, accessibility, sustainability, reliability, tendering) and modeling of public transport (multi-modal networks, path building and assignment). Attention is paid to user needs of the traveler (tariff, marketing, image, communication, information provision, safety and accessibility).

Land Use and Transport Interactions	
Responsible lecturer:	Prof.dr.ing. K.T. Geurs
Course code:	201000025
Period:	3
ECTS:	7,5

Course description:
Transport and land use are strongly interrelated. It is well-known that the quality of transport services influences the attractiveness of locations of activities (working, living, etc.). Land use density, diversity and neighbourhood design influences transport demands. The links between land use and transport is however complex, difficult to disentangle from other factors, and in transport planning often ignored. The course focuses on transport and land use interactions in the Western world, in particular Europe and the United States, but attention will also be paid to the developing world. This course contains three parts:

1) it treats theories and empirical evidence on land use and (passenger) transport interactions
2) the course deals with Land-Use and Transport Interaction (LUTI) models
3) the course deals with the practice of integrated land-use and transport planning.

Transport Modelling	
Responsible lecturer:	Dr. L.C. La Paix Puello
Course code:	201100008
Period:	2
ECTS:	7,5

Course description:
The course outlines:
- Mathematical modelling of individual behaviour, travel and market choices
- Stated / revealed preference surveys
- Discrete choice modelling theory and workshops

Traffic Operations	
Responsible lecturer:	dr. T. Thomas
Course code:	201100005
Period:	2
ECTS:	7,5

Course description:
This course is about the description and measurement of traffic operations. The theory of traffic flows deals with basic variables as intensity, velocity and density and concepts as jam density, optimal velocity, capacity, car following behaviour and shock waves. Several techniques to recognize and quantify these concepts are discussed. Statistical techniques are used to study spatial and temporal variations in the relevant variables, and correlations between them. Statistical analysis will help the traffic engineer to interpret traffic flow data and corresponding variable estimates in a meaningful way.

Transport Research Project	
Responsible lecturer:	Ir. K.M. van Zuilekom
Course code:	201100009
Period:	1, 2, 3, 4
ECTS:	7,5

Course description:
The goal of this course is to develop research skills in research on behave of and supervised by a PhD student of the Centre for Transport Studies. To perform research in cooperation with and supervised by a PhD student of the Centre for Transport Studies.

Intelligent Transport Systems	
Responsible lecturer:	Prof.dr. M.H. Martens
Course code:	201100010
Period:	1
ECTS:	7,5

Course description:
The course provides basic fundamental theories and tools that can be used to design, develop, and assess the ITS system. These include the analysis on user aspects, analysis on traffic and transport impact, behavioural changes and risk analysis. Participating students will select their interested area and formulate an ITS case study for their further assignment. In groups of 2, students apply these tools in their case study and present their results. Several guest lecturers will focus on special issues.

Rail Transport	
Responsible lecturer:	Ir. K.M. van Zuilekom
Course code:	201100013
Period:	3
ECTS:	7,5

Course description:
This course contains the transportation chain, characteristics of rail vehicles, the characteristics of the rail infrastructure, the switch, the safety systems, Energy supply, Track concepts, Stations and the influence on the environment.
At the end of the course the student has developed insight in the design and exploitation of rail infrastructure, and has applied a feasibility study for a passenger rail service.

Mathematical Optimization in Transport	
Responsible lecturer:	Prof.dr.ir. E.C. van Berkum
Course code:	201100012
Period:	3
ECTS:	7,5

Course description:
This course provides mathematical techniques which are commonly used Traffic Engineering. Basic concepts of graph theory, routing problems, characteristics of graphs, optimization problems with and without boundary conditions, linear programming, Langrangian and Karush-Kuhn-Tucker conditions, unicity, multi-variate optimization methods, convex combination method, heuristic equilibration techniques, system optimum and user optimum.

Hydrology	
Responsible lecturer:	Dr.ir. M.J. Booij
Course code:	195400100
Period:	1
ECTS:	7,5

Course description:
Hydrology deals with that part of the hydrological cycle occurring around the earth surface. It constitutes the link between weather and climate on the one hand and movement of water in rivers on the other hand and therefore plays a central role in water management. Knowledge of amounts of water, corresponding frequencies and the speed of runoff are of major importance to estimate impacts of measures and changes in a river basin on for example river discharge. Next, this knowledge can be used to support water policy and management in rural and urban areas. In this course, the hydrological cycle from precipitation to river discharge is considered, in particular the links which are important for the civil engineer

Hydraulic Engineering	
Responsible lecturer:	Dr. J.J. Warmink
Course code:	195410300
Period:	4
ECTS:	7,5

Course description:
This course focuses on the hydraulic engineering of water works. Hydraulic engineering contains the knowledge on the design, construction and maintenance of works and systems that are designed in answer to community needs for infrastructure that has to deal with water in all kind of ways. The goal of the course is in short: (1) to get acquainted with various hydraulic constructions, (2) to know what the use of the hydraulic constructions is, (3) to understand how they are designed, constructed and maintained. Using dikes, locks and dunes as examples, materials, failure mechanisms and calculations techniques will be introduced. Furthermore, the design and construction of several special structures will be introduced, such as tunnels, harbours, and wind turbines. The focus of the course is on the overview of technical aspects.

Water Systems	
Responsible lecturer:	dr.ir. D.C.M. Augustijn
Course code:	201300077
Period:	1
ECTS:	7,5

Course description:
The course Water Systems gives a qualitative introduction into marine systems, river systems and water quality. The parts on marine systems and river systems prepare for the more quantitative and advanced courses Marine Dynamics and River Dynamics. The objective of this course is to give a qualitative description and explanation of the physical and biochemical processes in surface water systems to estimate and understand the possible consequences of human interferences.

Integrated Water Management	
Responsible lecturer:	Dr. M.F. Brugnach
Course code:	195400300
Period:	4
ECTS:	7,5

Course description:
In this course student will learn about process management, participation, policies and institutions for managing water resources, paying particular attention to problems of urban water management.
To reach this goal students must:
1. Understand in depth the complexity of the couplings of the physical water and social systems, as well as the policy considerations from various institutional layers.
2. Understand in depth process based concepts and how to design a process based approach.
3. Know how to cope with uncertainty in multi-actor systems.
4. Know about the policy development in the field water.

River Dynamics	
Responsible lecturer:	Dr.ir. J.S. Ribberink
Course code:	195400400
Period:	4
ECTS:	7,5

Course description:
The objective of the module is to learn basic knowledge about fluid flow, transport processes and morphological phenomena (erosion / sedimentation) in surface waters such as rivers, estuaries and seas. These processes generally play an important role in most water management problems. This course consists of two parts:
- Shallow water flows
- Transport processes and morphology

Design Project Water II	
Responsible lecturer:	Dr. M.S. Krol
Course code:	195400500
Period:	2
ECTS:	7,5

Course description:
The central goal of the course is, to learn and perform a design process for an integrated water management problem. This involves a sound problem diagnosis involving physical insight in the system and policy insight in functional demands, a creative search for solutions, and an appropriate evaluation and selection of a preferred design.

The project targets to gain experiences in a way of designing that connects to the expected future professional environments of students with the specialization of water engineering and management. The final design should comply with management requirements related to high flow conditions, but also be consistent with current policies on nature and landscape development.

Tools for Water Policy Analysis	
Responsible lecturer:	Prof.dr. J.C.J. Kwadijk
Course code:	195400600
Period:	3
ECTS:	7,5

Course description:
This course will address the broad theme of modelling development and use to support water policy making processes. The extent to which models can discern alternative measures form the philosophical starting point to the design of such tools. During the course different modelling approaches, techniques and applications will be explored. Practical examples are taken from river studies with applications related to drought, water quality and flood risk. The main objective of this course is to teach how to handle models critically. Particular attention is given to:
1. the identification of the type of modelling approach needed in different managing situations,
2. the acknowledgement of bottlenecks in the design and application of quantitative and qualitative models to support integrated water management.

Water Footprint Assessment	
Responsible lecturer:	Prof.dr.ir. A.Y. Hoekstra
Course code:	201400010
Period:	1
ECTS:	7,5

Course description:
The aim of the course is that participants develop understanding of the intricate relation between freshwater and the functioning of societies and economies at large, and the role governments, companies, farmers, investors and consumers have in achieving a sustainable, efficient and equitable use of freshwater systems. The course is characterized by an interdisciplinary approach, in which knowledge and techniques from different disciplines are brought together in order to arrive at an integral understanding of the impact of humans on freshwater systems and, vice versa, the societal and economic impact of freshwater scarcity and pollution. Substantial attention will be paid to the global and cross-sector dimension of water management.

Data analysis in Water Engineering & Management	
Responsible lecturer:	Dr. K.M. Wijnberg
Course code:	195410100
Period:	2
ECTS:	7,5

Course description:
Observational data are an important source of information for understanding and predicting the behaviour of water systems. Concerning prediction, data are often used for calibration and validation of mathematical models. However, using the right analysis tools observational data can also provide useful information all by themselves. This course focuses on this second type of data use.
To extract information from data, a wide variety of analysis techniques and tools are available, each with its own merits and drawbacks. This course treats a selection of techniques commonly used in the field of water engineering and management. Since real world data sets tend to be imperfect, and the professional reality is that you have to select the most appropriate analysis method yourself, this course will also teach you a general strategy on how to properly perform a data investigation.

Marine Dynamics	
Responsible lecturer:	Dr.ir. B.W. Borsje
Course code:	195400800
Period:	1
ECTS:	7,5

Course description:
This course focuses on a quantitative description of marine processes, which were considered in a more qualitatively sense in the course Marine Systems (195400240). These topics cover tides (generation and propagation), (short) waves, sediment transport and coastal morphology.
The objective is to be able to quantitatively describe and explain hydrodynamic and morph dynamic phenomena in the marine environment (and to know how these topics are dealt with in a more practical engineering environment).

Morphology	
Responsible lecturer:	Prof.dr. S.J.M.H. Hulscher
Course code:	195410200
Period:	2
ECTS:	7,5

Course description:
In the course Morphology five topics are discussed that have a relation with morphology of rivers, estuaries, coasts and seas. Physics play an important role in this. Because understanding and predicting morphology is often necessary to support control, the link with practice often comes into play. By means of recent scientific papers several topics are studied; these papers are presented by students and the topic is discussed using associated assignments. Moreover, every student reviews a paper, that is ready to submit or just submitted to a peer-reviewed journal.
For the course in Morphology students need to do the course in Mathematical physics of water systems at first.

Mathematical Physics of Water Systems	
Responsible lecturer:	Dr.ir. P.C. Roos
Course code:	195400900
Period:	3
ECTS:	7,5

Course description:
This course deals with the aspects of mathematical physics that are commonly encountered in Water Engineering (and Management). The general objective is to be able to deal with differential problems that appear in water engineering and management. This can be divided into:
1) become acquainted with the physical background of differential problems (derivation, dimensions, scales, initial and boundary conditions),
2) apply analytical solution techniques, and gain insight in the fundamental behaviour of solutions,
3) apply elementary numerical solution techniques and understand their properties.

GRADUATION IN TWENTE

Preparation Master Thesis	
Responsible lecturer:	Dr.ir. C.M. Dohmen-Janssen
Course code:	195889000
Period:	-
ECTS:	7,5

Course description:
The main objective of the course Preparation MSc-thesis project is to independently produce a research or design plan for his/her MSc-thesis project, based on state-of-the-art scientific knowledge of the sub-field and acquire additional knowledge to prepare for the MSc-thesis project. The MSc-thesis project is a large individual research or design project in one of the sub-fields of Civil Engineering and Management.
Based on a meeting with the thesis supervisor, the student will make a plan that contains the following information: outline of the thesis subject, knowledge to be gained (literature, software, and methodology), examination mode(s) and planning.
Based on this plan the student will deliver the following products:
- Research plan
- Proof of sufficient prior knowledge based on examination mode(s)

CME Master Thesis	
Responsible lecturer:	Dr.ir. R.S. de Graaf
Course code:	195899999
Period:	1,2,3,4
ECTS:	30

Course description:
The student will have to prove that he/she meets the objective of the programme which means academic knowledge, understanding and skills in the domain of civil engineering and certain sub-domains of business administration and public administration at a level which qualifies the graduate for independent professional practice and research in civil engineering.
It can either be a research project or a systematic design (of a model, object or procedure).
The assignment can be executed at one of the departments of CiT, for example a research project that contributes to a PhD dissertation. The assignment can also be executed externally at a company or an institution.

NOTES