3TU.

STUDYGUIDE
ACADEMIC YEAR 2014-2015

3TU Programme in
Construction Management & Engineering

TU Delft

TU/e

UNIVERSITEIT TWENTE.

TABLE OF CONTENTS

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 AT DELFT

At TUD, the programme can focus on one of two aspects: 1) process and system innovation in the building industry in general or 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. Courses that are characteristic of TUD include the following: Dynamic control of projects, Financial Engineering, Probabilistic Design and Parametric Design.

FOCUS AT 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: Entrepreneurship, Research approaches for CMUD and Special Subjects for CMUD such as BIM and city modeling.

FOCUS AT TWENTE

At UT, the 3TU Master's degree programme in CME focuses on the management of the design and construction process within the building industry. It produces graduates who have sound knowledge of both engineering and organisational aspects. This combination is essential to current practices of complex, innovative and multidisciplinary projects within a dynamic environment. The market environment and the attention that is paid to the organisation and management of the various stages of the building process are central elements in the UT approach. Keywords for UT include the following: cooperation through the whole life cycle, helicopter view, stakeholder approach and engaged scholarship. The emphasis is on designing, managing and organising 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 at 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 at 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 University of Eindhoven 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 University of Eindhoven.

   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)

3. Sign up at the study advisor at the TU/e, dhr. W.J. Buurke (w.j.buurke@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 AT 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 AT 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 AT TWENTE

1. Network approach: inner-city area development from network approach, stakeholders approach, process management. Also towards engineering and design processes: collaborative design (Chair of Geert Dewulf).
2. Market research (Chair Andre Doreé). What does the construction market look like? Innovation, process technology: planning, and Risk Management (Joop Halman), sustainable building processes (how should the processes come together, and how to manage the life cycle).
3. Building processes: building processes and project management. Collaborative processes throughout the complete life cycle. Systems Engineering, as part of the design processes and applied in practice.
4. Asset Management in infrastructure and lifecycle approach.

ORGANISATION OF THE PROGRAMME IN CME

DIRECTORS OF EDUCATION AT THE THREE LOCATIONS

DIRECTOR OF EDUCATION AT DELFT
Drs.ir. J.G. (Jules) Verlaan
Room: Hoofdgebouw 3.48
Telephone: 015 278 7467
E-mail: j.g.verlaan@tudelft.nl

DIRECTOR OF EDUCATION AT EINDHOVEN
Prof.dr. H.J.P. (Harry) Timmermans
Room: VRT 8.18
Telephone: 040 247 2274
E-mail: h.j.p.timmermans@bwk.tue.nl

DIRECTOR OF EDUCATION AT TWENTE
Dr.ir. C.M. (Marjolein) Dohmen-Janssen
Room: Horst Z-219
Telephone: 053 489 4280
E-mail: c.m.dohmen-janssen@utwente.nl

PROGRAMME DEVELOPER 3TU-CME
Ir. S. (Sven) Laudy
Telephone: 06-41035617
E-mail: s.laudy@utwente.nl

STUDY ADVISORS AT THE THREE LOCATIONS

STUDY ADVISORS AT DELFT

K.O. (Karel) Karsen
Room: 2.77.1
Telephone: 015 278 3337
e-mail: k.o.karsen@tudelft.nl

Drs. P. (Pascal) de Smidt
Room: 2.79
Telephone: 015 278 1068
E-mail: p.desmidt@tudelft.nl

STUDY ADVISOR AT EINDHOVEN

Drs. W.J. Buurke
Room: VRT 2.12
Telephone: 040-2475981 (if no answer: 040-2473990)
E-mail: w.j.buurke@tue.nl

STUDY ADVISOR AT TWENTE

Ir. J. (Judith) Roos-Krabbenbos
Room: Horst Z-224
Telephone: 053-4892341
E-mail: j.roos-krabbenbos@utwente.nl

EXAMINATION COMMITTEES AT THE THREE LOCATIONS

EXAMINATION COMMITTEE AT DELFT

Members of the Examination Committee at Delft:

- Chairman: Dr. R. Schoenmaker
- Member: Drs. M. Leijten
- Member: Mr. F.A.M. Hobma

EXAMINATION COMMITTEE AT EINDHOVEN

Members of the Examination Committee at 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)
- Member: vacancy
- 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 AT TWENTE

Members of the Examination Committee at 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)
- Member: Dr. J.T. Voordijk
- Register: Drs. E Ruijgh

EDUCATION COMMITTEES AT THE THREE LOCATIONS

EDUCATION COMMITTEE AT DELFT

Members of the Education Committee at Delft:

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

EDUCATION COMMITTEE AT EINDHOVEN

Members of the Education Committee at 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)
- Student member: M.P.T. van Melzen (CME)
- Secretary: mrs. J.A.M. Pulles (VRT 2.12)
  J.A.M.Pulles@tue.nl - 040-2478725

EDUCATION COMMITTEE AT TWENTE

Members of the Education Committee at Twente:

- Chairman: Prof.dr.ir. K.T. Geurs
- Member: Ir. G.H. Snellink
- 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: P.C. Drenth
- Student member: G. Feitsma
- Student member: J.V. de Vries
- Student member: P.W.J.M. Willemsen
- Advisor: Dr.ir. C.M. Dohmen-Janssen
- Advisor: Drs. L.A. Woud - Van der Graaf
- Secretary: Drs. E. Ruijgh

STUDY ASSOCIATIONS AT THE THREE LOCATIONS

STUDY ASSOCIATION AT DELFT

Study association CME Dispuut
Room 3.53
Postbus 5048
2600 GA Delft

Location
Stevinweg 1
Room 3.53
2628 CN Delft
Phone: 015-2785012
E-mail: info@cmedispuut.nl
Website: www.cmedispuut.nl/

STUDY ASSOCIATION AT EINDHOVEN

Study association of CoUrsE!
Vertigo Vloer 8
Postbus 513
5600 MB Eindhoven
E-mail: info@ofcoursecme.com
Website: www.ofcoursecme.com/

STUDY ASSOCIATION AT TWENTE

Study association ConcepT
Studievereniging ConcepT
Postbus 217
7500AE Enschede
Telephone: 053 489 3884

Location
Horst(basement) C-016 C-018
Drienerlolaan 5
7522 NB Enschede
Opening hours: Monday - Friday 09:00-16:30
E-Mail: ConcepT@ConcepT.utwente.nl
Website: www.concept.utwente.nl/

ALUMNI ASSOCIATIONS AT THE THREE LOCATIONS

ALUMNI ASSOCIATION AT DELFT

CME Dispuut
TU Delft, Faculty CEG
Room 3.53
Postbus 5048
2600 GA Delft

Location
Stevinweg 1
Room 3.53
2628 CN Delft
Phone: 015-2785012

E-mail: info@cmedispuut.nl
Website: www.cmedispuut.nl/
LinkedIn: www.linkedin.com/groups/CME-Alumni-3663314

ALUMNI ASSOCIATION AT EINDHOVEN

Study association of CoUrsE!
Vertigo Vloer 8
Postbus 513
5600 MB Eindhoven

Email: info@ofcoursecme.com
Website: www.ofcoursecme.com/
LinkedIn: www.linkedin.com/groups?gid=126804

ALUMNI ASSOCIATION AT TWENTE

Alumni Association ConcreeT
p/a Alumni bureau Universiteit Twente
Postbus 217
7500 AE Enschede

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

CORNERSTONE COURSES AT THE THREE LOCATIONS

The study programme is composed as follows:

a. Core programme (cornerstones), 29 – 32 EC
b. Specialism-related courses, 30 – 45 EC
c. Optional courses, 0 – 15 EC
d. Graduation work, 32 – 40 EC

CORNERSTONES AT 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

CORNERSTONES AT EINDHOVEN

Course Code	Name	Period	Responsible lecturer	EC
7C800	Legal & Governance	1	Prof.dr.ir. W.F. Schaefer	8
1ZM65 / 1CM90	Project Management (System Dynamics)	1,2	Dr.ir. B. Walrave Dr.ir. R.A.C.M. Broekmeulen	5+3
7C510	Process Management	3,4	Dr. Q. Han	8
7M885	Collaborative Design & Engineering	3,4	Prof.dr.ir. B. de Vries	8

CORNERSTONES AT TWENTE

Course Code	Name	Period	Responsible lecturer	EC
195800100	Legal & Governance	1	Dr. P.J. Klok	7,5
195800200	Project Management	2	Dr. S.H.S. Al-Jibouri	7,5
195800300	Process Management	1	Dr. M. Smit	7,5
195800400	Collaborative Design & Engineering	3	Dr.ir. R.S. de Graaf	7,5

At the University of Twente, the course in 7,5 EC course in Research Methodology and Academic Skills (195820400) is mandatory (unless this course was part of the pre-master's programme of the student).

OVERVIEW OF THE COURSES AT DELFT

SPECIALISATION COURSES AT DELFT

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

Course description:
In order to improve project performance, new methods of control are required that are able to cope with changes in the built environment during its lifetime. After this course, you are able to
1. Perform a complexity assessment on a real life project
2. Explain the results of such a complexity assessment and the implications it.
3. Chose management approaches to deal with different types of project complexity.
4. Design a knowledge management system for complex projects.
5. Describe the advantages and disadvantages of innovative contract types in complex projects.
6. Set-up an ideal project organization to enable dynamic control.

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.

Methodology for Scientific Research	
Responsible lecturer:	Prof.dr.ir. K. van Breugel
Course code:	CIE4030
Period:	4
ECTS:	3

Course description:
After the course the student is able to design a research project, apply the proper statistical testing theory and to examine critically the literature on his field of study and the proper research methodology. Also, the student is aware of some theories concerning project management.

Infrastructure Projects; Assessment and Planning	
Responsible lecturer:	Dr.ir. R.J. Verhaeghe
Course code:	CIE4760
Period:	2
ECTS:	6

Course description:
The main goal of the course is to provide the student with basic knowledge, - insights and - analytical tools to assess and plan infrastructure projects. After passing the course the participant will be able to prepare his/her own assessment and plan, or make a critical review of existing ones. Based on the many worked examples the course will further provide the participant with a sense (combination of technical/financial/economical insight) for optimization of infrastructure projects/plans.

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, an Ethics module and a Technology Assessment Module.

Integration & Orientation	
Responsible lecturer:	Dr. R. Schoenmaker
Course code:	CME1210
Period:	2
ECTS:	7

Course description:
The course has two purposes. The first purpose is to integrate newly acquired and previously acquired methods, techniques, aspects and tools for multidisciplinary design, engineering and management. The second purpose is to orientate on different viewpoints by critically looking at multidisciplinary design, engineering and management problems from those various viewpoints.

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

Course description:
Topics: After the course, the student has to be able to do Level I, II and III calculations, risk-based optimisations and system probability calculations. Application areas: Structural safety of buildings, dikes, offshore platforms, bridges etc., Maintenance and management, Quality assurance, Safety management, Geostatistics, Reliability of software.

ELECTIVE COURSES AT DELFT

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

Course description:
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. After the course student is able to 1) understand the major value drivers in an appraisal, 2) is able to understand conceptual valuation issues, 3) is able to apply sensitivity analysis in valuations, and 4) is able to understand corporate finance issues and address accounting issue

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 lecture is about a new perspective on the application of Operations Research (Decision Making Engineering) in Design & Construct Management. This perspective is that technical optimisation and social optimisation should not be carried out separately, but be integrated into one design & construct process. This process is labelled as open design & construct because of its characteristic feature of openness in how decisions come about.

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. At least part of the practical work is dedicated to an individual (research) assignment, to be agreed upon with the internship coordinator.

Economics	
Responsible lecturer:	Dr.ir. R.J. Verhaeghe
Course code:	CIE4010
Period:	2
ECTS:	4

Course description:
The course provides insight into the economic background of engineering projects with the objective to contribute to a complete and efficient decision making in planning and design.

Multidisciplinary Project	
Responsible lecturer:	M. van Eijck
Course code:	CIE4061
Period:	1
ECTS:	10

Course description:
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.

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.

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-actor environments. They learn about the role of policy analysts in politicized situations; about policy styles, stakeholder analysis techniques and the role of information in policy processes.

Economics of Infrastructures	
Responsible lecturer:	Prof.dr. R.W. Kunneke
Course code:	EPA1233
Period:	3
ECTS:	6

Course description:
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
ECTS:	6

Course description:
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.

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 modeling 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.

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 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.

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.

Introduction to bed, bank and shore protection	
Responsible lecturer:	Ir. H.J. Verhagen
Course code:	CIE4310
Period:	2
ECTS:	4
Course description: This course contains: Design of shoreline protection along rivers, canals and the sea; load on bed and shoreline by currents, wind waves and ship motion; stability of elements under current and wave conditions; stability of shore protection elements; design methods, construction methods.	

Water Laws and Organisation	
Responsible lecturer:	Dr. E. Mostert
Course code:	CIE5500
Period:	2
ECTS:	3
Course description: Water law is of great importance for water management and civil engineering. It deals with concrete issues such as: how safe should the dykes be?; which water quality standards have to be reached?; who should take action?; and: who has to pay? The purpose of this course is to give the students insight into the content and development of Dutch water law and its importance for water management and the work of engineers.	

Introduction to Offshore Engineering	
Responsible lecturer:	Prof.dr.ir. M.L. Kaminski
Course code:	OE4606
Period:	1
ECTS:	3
Course description: The course starts with description of offshore environment and loads exerted on offshore structures. Then the response of offshore structures to these loads is explained. After that, design aspects of representative floating and bottom founded offshore structures including drill ships and jack-ups are described. Separate lectures are devoted to the stability and mooring of floating offshore structures, subsea, flow lines, offshore wind energy and wind turbine installation vessels. Finally, the whole process of oil and gas field development is outlined. Most of the lectures include a practical calculation exercise.	

Introduction to Dredging Engineering	
Responsible lecturer:	Prof.dr.ir. C. van Rhee
Course code:	OE4607
Period:	1
ECTS:	3
Course description: This course includes Excavation processes, Cutting theory for sand clay and Rock. Hydraulic transportation of solid particles, Dredging Equipment, Production calculations.	

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

Course description:
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.

Design of urban concepts	
Responsible lecturer:	Dr. B. Waterhout Prof.dr. W.A.M. Zonneveld
Course code:	SPM4710
Period:	1
ECTS:	4

Course description:
This course will address a variety of spatial concepts, their use and development over time and evaluate their performance. By means of introduction the course will address some well-known spatial concepts such as the Green Heart, buffer zones and urban networks – which used to be cornerstones of Dutch spatial planning policy – and how these concepts have been transformed into novel approaches and concept such as transit oriented development and 'room for the river'. We will address how spatial concepts can play a role in the multi-actor, scalar and sector processes characterising spatial development and water management of today.

Design of Housing Programs	
Responsible lecturer:	Dr. H.M.H. van der Heijden
Course code:	SPM4720
Period:	2
ECTS:	5

Course description:
Upon completion of the course, the student:
• Has knowledge of the process of designing a housing program and the role of the actors involved
• Can apply different qualitative and quantitative methods of measuring housing demand and is aware of the pitfalls
• Can translate the results of housing demand survey's into a housing program
• Knows how a housing program can be used in urban (re)development strategies

Strategies in urban restructuring	
Responsible lecturer:	Dr. R.J. Kleinhans
Course code:	SPM4730
Period:	3
ECTS:	4

Course description:
This course deals with urban restructuring and area redevelopment strategies in Dutch cities. The focus is on restructuring of existing urban neighbourhoods. The course will delve into policy, governance, and legal aspects of restructuring and area (re)development. Strategies and behaviour of various actors are taken into account. The theory will be illustrated with several cases.

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.

Sustainable Business Game	
Responsible lecturer:	E.M. Blom Dr. K. Hemmes
Course code:	WM0943TU
Period:	3
ECTS:	5

Course description:
The course assists and stimulates students in assessing the market potential of their own business idea; a sustainable product or service.
The course consists of two parts:
1. students attend lectures and workshops.
2. students carry out a feasibility study for their own product or service.

GRADUATION AT 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.

OVERVIEW OF THE COURSES AT EINDHOVEN

SPECIALISATION COURSES AT EINDHOVEN

Entrepreneurship: Literature	
Responsible lecturer:	Dr. M.M.A.H. Cloodt
Course code:	1ZS01
Period:	1
ECTS:	3

Course description:
Entrepreneurship is a vital source of change in all facets of society. This course is about technology entrepreneurship, the creation, discovery and exploitation of technology-intensive business opportunities. This course introduces students to the literature on technology entrepreneurship.

Entrepreneurship: Business Plan Development	
Responsible lecturer:	Dr. M.M.A.H. Cloodt, Dr.ing. J.P.M. Wouters
Course code:	1ZS02
Period:	1, 2
ECTS:	3

Course description:
This course is about technology entrepreneurship, the discovery and exploitation of technology-intensive business opportunities. This course introduces you to the literature on technology entrepreneurship as well as provides an opportunity to enlarge your practical skills by an action-oriented approach to the subject through the development of a business plan for a high-tech start-up company.
When developing a commercial and financially feasible business plan for a high tech start-up company, all key aspects of a venture are dealt with: strategy, business modelling, networking, organisational structure, intellectual property rights, business liabilities, market survey, team building and human resource management, road mapping, financial plan and control instruments, and the exit strategy.

Entrepreneurial marketing	
Responsible lecturer:	Dr.ing. J.P.M. Wouters
Course code:	1ZM75
Period:	1
ECTS:	3

Course description:
This course is set up:
- To provide students with knowledge of how to bridge the marketing discipline and the entrepreneurial field.
- To provide guidelines and tools to deal with entrepreneurial side of marketing
- To provide guidelines and tools to deal with the marketing side of entrepreneurship

Research Approaches for Construction Management & Urban Development	
Responsible lecturer:	Dr. Q. Han
Course code:	7CS15
Period:	3, 4
ECTS:	14

Course description:
Students will work in teams on applying research methods which are important to apply in graduation projects. Several research methods will be introduced by staff members. Based upon the methods, students will make clear analysis of problem definitions and elaborate conceptual research models.

Special Subjects for Construction Management & Urban Development	
Responsible lecturer:	Dr.ir. B. Glumac
Course code:	7CS25
Period:	1, 2 (second year)
ECTS:	14

Course description:
The context that we will use in the simulation part of this course is that of household energy use. In the last three decades, the topic of household energy use and savings has attracted a lot of attention in the scientific society. With better insights into the energy use of a household, we could determine how much certain behavioural and physical changes could impact the household energy demand.

ELECTIVE COURSES AT EINDHOVEN

Career development	
Responsible lecturer:	Prof.dr.ir. W.F. Schaefer
Course code:	7CM40
Period:	4
ECTS:	3

Course description:
Participants will become more aware of their own strengths and learning points where it is their personality and skills concerned. They will gain more insight in their own wishes where it is jobs and companies concerned and will know how to use sources to orientate themselves on the job market more efficiently. Finally they will know how to present themselves both written and face to face and are in charge of organizing their own career event.

Decision Support for Planning and Design	
Responsible lecturer:	Dr. T.A. Arentze
Course code:	7M840
Period:	3
ECTS:	3

Course content:
1. methods of structuring complex planning and design decision problems;
2. techniques to evaluate and rank decision alternatives on a set of criteria;
3. techniques to simulate pedestrians/users;
4. techniques to deal adequately with uncertainties regarding the consequences of decisions;
5. existing systems for planning and design support that combine several of these techniques in a single system;
6. in assignments, students apply existing tools with regard to each of the methods, techniques and systems to realistic problems in planning and design.

Fundamentals in Building Information Modelling	
Responsible lecturer:	Ir. J. Dijkstra
Course code:	7M900
Period:	1,2
ECTS:	5

Course description:
This course is of importance to everyone who needs to use building information and who can work on developments in BIM and/or fundamentals of BIM. The student learns to model with the visual modeling 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. The student learns 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. The student also learns 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.

Corporate Entrepreneurship	
Responsible lecturer:	Dr.ir. B. Walrave
Course code:	1ZS20
Period:	3
ECTS:	3

Course description:
The course examines entrepreneurial behavior within the context of established organizations. It will discuss the two major forms of corporate entrepreneurship: corporate venturing and strategic entrepreneurship (with a focus on innovations that are adopted in the firm's pursuit of a sustainable competitive advantage). Whereas the first part of the course sets the foundations and provides a general overview of corporate entrepreneurship, the second part moves into selected topics, such as corporate venture capital, corporate incubators, and corporate entrepreneurship through acquisitions and strategic alliances.

Construction Law for MSc	
Responsible lecturer:	Mr.ing. E.P. Mol
Course code:	0E501
Period:	3, 4
ECTS:	6

Course description:
Private construction law gives insight in the relationship between the (citizen) participants in the construction process. The law and legislation is essentially restrictive, not compelling. Mainly the relationship between client, contractor and architect will be discussed. Therefore the following topics will be discussed in the lectures: land development, business law, neighbors' law, building funds, the architects agreement, position and activities of the architect, contracting, building contracts, liability in construction, insurance in construction, building jurisdiction and international building law.

Urban Strategies and Finance	
Responsible lecturer:	Dr. J.J.A.M. Smeets
Course code:	7U995
Period:	3
ECTS:	3

Course description:
-

Entrepreneurship and Corporate Social Responsibility	
Responsible lecturer:	Dr. J.K. Katzav
Course code:	0ZS01
Period:	4
ECTS:	3

Course description:
The course is divided into two parts. In the first part we clarify the hazard to which business ethics is a response and to identify the idea of conscience in relation to corporate culture. We will examine the role of moral reflection (conscience) in the lives of each of us as individuals and the corresponding role it plays in the culture of an organization. The second part focuses on the application of the conceptual foundations laid in the first part. Especially attention will be paid on the moral agenda of leadership, ecological responsibilities, and globalization.

Business Law	
Responsible lecturer:	Prof.mr.dr. J.M. Smits
Course code:	0AM05
Period:	3
ECTS:	3

Course description:
Business Law as understood in this course deals with the essential (fiscal and legal) subjects that together form a firm, i.e. Selection of Business Organisational Form, Types of Corporations; Formation, Corporate Purpose, Distribution of Powers; Management of Business Affairs concluding different types of contracts, Commercial Register; Public Filings, and Taxation issues. Understanding the systematic place of Corporate law in the overall legal system is also important, this issue however will be addressed in an indirect way by continuously explaining and placing the subject at hand in the legal system.

Entrepreneurial Finance; Introduction	
Responsible lecturer:	Dr. S.A.M. Dolmans
Course code:	1ZS21
Period:	3
ECTS:	3

Course description:
The focus of this course is on developing and discussing a set of financial methods and skills that can be applied to new (technology) ventures. Specific topics include: new (technology) ventures; resources; sources of funding, the venture capital industry; technology and company valuation; deal structuring and real options. In the course we discuss the various sources of capital that are available for new ventures including venture capital and financial decisions of new (technology) ventures at various phases of their life cycle.
Throughout the course analytical tools will be introduced and applied to relevant cases. Financial analysis, various valuation methods, negotiations, and deal structuring will be examined in the context of entrepreneurial firms. These analytical methods are complemented with cases.

Urban systems: Analyses & Modeling	
Responsible lecturer:	Ir. A.W.J. Borgers
Course code:	7M860
Period:	2
ECTS:	5

Course description:
This course introduces the principles and assumptions underlying models and methods used in the field of land use planning and transportation planning. Forecasting population provides information to assess future demand for housing and services. Land use suitabilities help planners to find the best locations for land uses and to generate different plans for spatial development in an area. The selection of a plan can be supported by means of evaluation techniques. The traffic network affects the accessibility of residential, work, and service locations and also influences the traffic flows between these (and other) locations. Discrete choice models will be introduced to explain choice behaviour of people in a spatial context, both in existing (real world) situations and possible future or experimental situations. Location/allocation models will be introduced to determine the best locations for specific facilities in a plan area, like shopping centres or schools. Land use models integrate these (and other) models into a system for planning future urban development.

New Media, Entrepreneurship and Innovation	
Responsible lecturer:	Dr. A.S. Leufkens MSc
Course code:	1ZM80
Period:	4
ECTS:	3

Course description:
Due to technological developments, new e-media, like the Internet, virtual communities, and social networks become increasingly important to entrepreneurship and innovation success. Recent literature emphasizes, for instance, the role of virtual customer communities and employee communities as a novel ways to contribute to the innovation process. Moreover, technological developments have resulted in more effective inter-firm cooperation when it comes to the development of new products. This course aims to focus on the role of new media in entrepreneurship and innovation processes.

Capita Selecta Real Estate Management & Development	
Responsible lecturer:	dr. J.J.A.M. Smeets
Course code:	7U991
Period:	2
ECTS:	3

Course description:
n.a.

Social Entrepreneurship	
Responsible lecturer:	Prof.dr. C.C.P. Snijders
Course code:	0A150
Period:	1, 2
ECTS:	3

Course description:
In this course we consider the theory and empirics of entrepreneurship and innovation from a network perspective. In what kind of networks are entrepreneurs more likely to see opportunities to create value? Which networks help entrepreneurs exploit opportunities and be successful? The course considers how theoretical and practical aspects of networking.
The theoretical part largely overlaps with the MSc course "Innovation in Networks and Alliance Management". In this part, general theories concerning networks and their application to innovation and alliance management are discussed. In the second part, the focus is on practical applications of general network theories to entrepreneurship.

Urban systems: Analyses & Modeling	
Responsible lecturer:	ir. A.W.J. Borgers
Course code:	7M860
Period:	1,2
ECTS:	5

Course description:
This course introduces models and techniques and their underlying principles and assumptions used in the field of land use planning and transportation planning. Examples in a simplified spatial setting will be used to demonstrate how to apply the models/techniques. Discrete choice models will be introduced to explain choice behavior of people in a spatial context, both in existing (real world) situations and possible future or experimental situations.

Management and organization (organizing study trip)	
Responsible lecturer:	-
Course code:	7N108
Period:	1,2,3,4
ECTS:	1

Course description:
Organising study trip

Management and organization (Board member of study association Of CoUrsE!)	
Responsible lecturer:	
Course code:	7N208
Period:	1,2,3,4
ECTS:	3

Course description:
Board member of study association Of CoUrsE!

Technology and sustainability	
Responsible lecturer:	Ir. A.F. Kirkels
Course code:	0C900
Period:	1
ECTS:	3

Course description:
After finishing this course you will have a deep understanding of the different pillars the concept of sustainability is building upon, as well as how the concept developed over time. Also you will be able to analyse complex sustainability problems that are both socio-economical and technical by nature. You will learn the basics of several analysis methods and be able to apply them - including actor, mass flow, life cycle, financial feasibility, and multi criteria analysis.

Energy and Consumer	
Responsible lecturer:	Dr. J.R.C. Ham
Course code:	0C903
Period:	1
ECTS:	3

Course description:
This course is designed to give the graduate bachelor engineer a foundation from which to understand and design interventions to change consumption and to promote use of certain technologies without suffering unwanted rebound effects. Students will be introduced to three general approaches on how to change human behaviour in environmental conservation.

Energy and Sustainability	
Responsible lecturer:	Dr.ir. E.M. van Veldhuizen
Course code:	3P250
Period:	4
ECTS:	3

Course description:
This course gives students the opportunity to analyse in detail a subject related to energy and sustainability. The student is free to choose because this enhances the motivation. Besides technical matters other relevant aspects must be taken into account, e.g. economic feasibility and social acceptability. Examples of possible subject are: wind mills, solar cells, nuclear fusion, fuel cells, biomass, consequences of running out of fossil fuel, free electricity market, etc.

Energy and economy	
Responsible lecturer:	dr. H.A. Romijn
Course code:	0EM72
Period:	2
ECTS:	3

Course description:
In this course, you will explore the manifold bi-directional relationships between energy and economic growth, and investigate the development of the energy sector over time - involving substitution of traditional by modern energy sources as economies develop, and increasing diversification in energy sources, carriers and applications.

Design of sustainable energy systems for the built environment	
Responsible lecturer:	Dr.ir. M.G.L.C. Loomans
Course code:	7S815
Period:	2
ECTS:	3

Course description:
General background: Climate - Indoor environment - Performance evaluation
Building level (design) Energy demand reduction - Energy production - Building energy management
District level: Energy flows - Smart grids
Building level (in-use): Commissioning - Operational performance

Sustainable Building 2	
Responsible lecturer:	Prof.dr.ir. H.J.H. Brouwers
Course code:	7S620
Period:	1
ECTS:	2

Course description:
This course addresses the sustainability of buildings, construction materials and products. This is done by considering the raw materials, way of production, as well as the environmental and technical properties of building materials, building products and the entire construction, including the possibilities of their recycling or re-use. Besides this material aspect, attention is also paid to land use, and sustainable water and energy systems.

System innovations and strategic niche management	
Responsible lecturer:	Dr.ir. R.P.J.M. Raven
Course code:	0C940
Period:	3
ECTS:	3

Course description:
The aim of the course is to provide the students with a theoretical framework based on innovation studies to analyse and understand the socio-technical nature of system innovations and the opportunities and barriers for the development of sustainable energy technologies or healthcare technologies.

Sustainable building and systems modeling	
Responsible lecturer:	Dr.ir. A.W.M. van Schijndel
Course code:	7Y700
Period:	3,4
ECTS:	3

Course description:
The students learn to apply modeling and simulation tools, to find optimal solutions and designs for sustainable building systems,
Furthermore, the students gain experience in:
- developing of models and simulating them using MatLab/SimuLink,
- evaluating the simulation results by estimated values.

GRADUATION AT EINDHOVEN

Research Proposal	
Responsible lecturer:	Prof.dr.ir. W.F. Schaefer
Course code:	7CC10
Period:	1,2,3,4
ECTS:	10

Course description:
The student will learn how to prepare and how to plan his/her complex final graduation study assignment: the individual research based graduation project.

Graduation Project CME	
Responsible lecturer:	Prof.dr.ir. B. de Vries Prof.dr.ir. J.W.M. Bertrand Dr. A.F.H.J. den Otter arch. AvB Dr. Q. Han Dr.ir. I.M.M.J. Reymen Mr.ing. E.P. Mol Dr. M.M.A.H. Cloodt Prof.dr. G.M. Duijsters Ing. J. Dijkstra
Course code:	7CC30
Period:	1,2,3,4
ECTS:	30

Course description:
At the TU/e the graduation specialization of CME consists of `Construction Management & Urban Development' (CMUD). This final graduation project 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 meeting: science concerning (urban) technical and organizational systems and management and innovation sciences.

OVERVIEW OF THE COURSES AT TWENTE

SPECIALISATION COURSES AT TWENTE

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.

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. Reality shows us this isn't an easy task.

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

Course description:
The main objective of the class 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.

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.

* The course in Research Methodology and Academic Skills (195820400) is mandatory (unless this course was part of the pre-master's programme of the student).

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.

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.

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

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.

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

Course description:
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

ELECTIVE COURSES AT TWENTE

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.

Sustainable Transport	
Responsible lecturer:	Dr.ir. M.H.P. Zuidgeest
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.

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).

Land Use and Transport Interactions	
Responsible lecturer:	Dr. L.C. La Paix Puello
Course code:	201000025
Period:	3
ECTS:	7,5

Course description:
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.

Traffic Operations	
Responsible lecturer:	Prof.dr.ir. E.C. van Berkum
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. Further the estimation of capacity and the monitoring and dynamic modeling of traffic operations, including the statistical properties of the several variables are studied.

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 modeling 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.

Transport Policy and Planning	
Responsible lecturer:	Prof.dr.ing. K.T. Geurs
Course code:	201100007
Period:	1
ECTS:	7,5

Course description:
The course Transport policy and planning aims to provide an overview of the role, contents and implications of transport policy and planning on different levels of scale. The course follows the elements of the transport policy cycle and focuses on European, Dutch national, regional and local transport policies. The transport policy cycle represents an iterative process with many actors going through the stages of problem recognition, policy development, implementation and evaluation.

Transport Modelling	
Responsible lecturer:	Ir. K.M. van Zuilekom
Course code:	201100008
Period:	2
ECTS:	7,5

Course description:
The course outlines Discrete choice modeling, Stated preference / revealed choice modeling, Aggregated models, Calibration, Recent literature on modeling Transport modeling, Design, application and analyses of a survey

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.

Intelligent Transport Systems	
Responsible lecturer:	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.

Intelligent Transport Systems Project	
Responsible lecturer:	Dr. M.H. Martens
Course code:	201100011
Period:	2
ECTS:	7,5

Course description:
The course consists of a group assignment where each group addresses a specific ITS problem as their course project. The problems and challenges are presented by external companies, who will facilitate the assignment together with the University. The task is to solve the problem, by applying available ITS tools/theory and by developing new ones.

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, Influence on the environment

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

Course description:
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. In this course, the hydrological cycle from precipitation to river discharge is considered, in particular links which are important for the civil engineer

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

Course description:
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:
The main objectives of the course are:
- to gain insight in the different components of urban water management
- to gain insight in the different user objectives of urban water and the inherent requirements
- to be able to assess the water system and water chain in urban areas
- to be able to design a multi-actor participatory process for water management.

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.

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.

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.

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

Course description:
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.

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

Course description:
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.

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.
For the course in Morphology students need to do the course in Mathematical physics of water systems at first

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

Course description:
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).

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

Course description:
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 AT TWENTE

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

Course description:
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.

NOTES