4TU.

TU Delft Delft University of Technology

TU/e Technische Universiteit Eindhoven University of Technology

UNIVERSITEIT TWENTE.

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Focus at the three CME locations

The challenge of Construction Management & Engineering (4TU)

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

The master's degree program Construction Management and Engineering (CME) is offered by the Built Environment (BE) and Industrial Engineering & Innovation Sciences (IE&IS) departments, with their distinctive research-driven and project-oriented approach to education. In this interdepartmental program the focus is Construction Management & Urban Development: using urban/building sciences and management and innovation sciences to develop solutions for urban development with particular emphasis on smart cities. CME graduation projects are closely related to ongoing research projects in the BE and IE&IS departments.

Courses that are characteristic of TU/e include the following: Urban Research Methods, Technological Entrepreneurship, Entrepreneurial Marketing, Built environment and smart mobility, Research and Development project, Smart Urban Environments, Project BIG data experiments for urban analysis, Fundamentals of BIM and Urban Planning II .

Focus in Twente

At the University of Twente, the 4TU 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, Collaborative Design & Engineering 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 4TU 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 s.laudy@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 s.laudy@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 s.laudy@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 student administration 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 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 the TU/e the graduation specialisation of CME consists of `Construction Management & Urban Development' (CMUD). The final graduation project has a clear scientific signature, and is grounded in actual CMUD challenges. CME graduation projects are often executed in collaboration with industry partners, engineering offices or government institutes. CMUD borrows from two scientific domains: (i) urban science and systems and (ii) management and innovation sciences.

The graduation project is executed across the two aforementioned scientific domains. Within this cross section students can choose from a list of subjects that are strongly related to on-going projects in the TU/e departments Built Environment (BE), and Industrial Engineering and Innovation Sciences (IE&IS). All subjects are clustered into the following research areas:

- Process engineering:
  When cities or urban districts are to be developed or redeveloped, complex decision-making and information processes are needed in order to bring shareholders and stakeholders together. Developing models for negotiation, data management, simulation of expected results and process governance are the focus of these graduation projects.
- Business engineering:
  Cities and urban districts are considered and approached in terms of entrepreneurial entities: profit and non-profit companies. In the individual graduation projects, the subjects are value features, exploitation possibilities, management and financing concepts.

For both research areas the following relevant societal and engineering topics, regarding smart city development are in focus:

- Energy management
- Urban management
- Information management

Graduation themes in Twente

The 4TU 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 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, the coordination of the activities and roles of parties involved.

Career opportunities after CME

After the CME master you can choose out of several options, such as directly ***working in industry***, a paid combination of education and working on a practical design in industry (***PDEng***), or a scientific career (***PhD***).

Career in industry

Career opportunities for CME graduates can be found across the full spectrum of the building and construction industry, in the Netherlands and abroad. Future employers may include building and construction companies, organisations such as insurers with their own project development department, engineering and design offices and consultancy firms, government and NGOs such as Rijkswaterstaat, and institutes of research and education.

Positions may vary from company or division manager, construction supervisor or construction manager to project manager, technical consultant, project engineer or process manager. Given the wide range of knowledge and skills provided by this MSc programme and the current situation within the industry, opportunities are very promising.

PDEng - Post-Master Technological Design Programmes

Instead of directly working in the building- and construction industry, there is the opportunity to follow one of the Post-Master's designer programmes in Civil engineering at the 4TU Stan Ackermans Institute.
The ***practical focused*** PDEng (Professional Doctorate in Engineering) programmes in Civil Engineering (UT) and Smart Energy Buildings and Cities (TU/e) are open for CME graduates. During the program you will increase your technological knowledge, but you also learn how to apply it in practice. As well as that you work on your professional skills to increase your career opportunities. It encourages to actively look beyond the perimeters of a discipline and to recognise the challenges and restrictions imposed by product chain management, time and money.

A PDEng programme consists of an educational programme on a post-MSc level (50%) and a design project within an organization (50%). During projects students bring industrial and academic knowledge together and apply them in real industrial designs. A PDEng programme is fulltime and takes two years to complete.

By doing a PDEng programme you will become a qualified designer. When the trainee successfully completes the programme, he/she will receive a certified diploma and will be entitled to use the academic degree PDEng. During both years a PDEng trainees receive a salary.

For more information you can check de websites of the PDEng Civil Engineering and the PDEng Smart Energy Buildings and Cities:

- PDEng Civil Engineering: www.utwente.nl/go/pdeng-civil-engineering
- PDEng Smart Energy Buildings and Cities: www.tue.nl/sebc

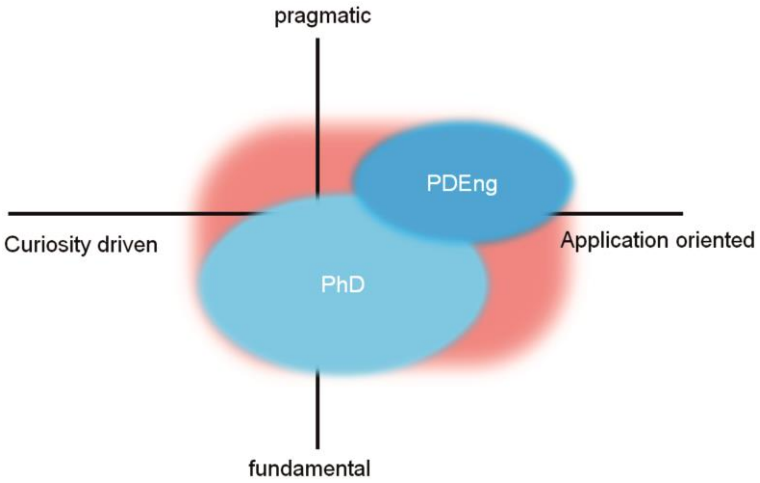
PhD - Doctoral Programmes

After completing your Master of Science degree, you also could opt for a career in ***research***. This involves spending four years studying a particular research area in depth. An integral part of this is writing your PhD thesis, and at the end of your PhD period you will present and defend your research in public. After successfully completing your PhD, you will be awarded the title of Doctor (Dr.).

Unlike in many other countries, most PhD researchers in the Netherlands are paid employees, often working directly for the university.

For more information you can check de websites of the graduate schools of each location:

- TU Delft: http://graduateschool.tudelft.nl/
- TU Eindhoven: https://www.tue.nl/en/education/tue-graduate-school/phd-programs/
- University of Twente: www.utwente.nl/tgs



Organisation of the 4TU CME Master programme

Directors of Education at the three locations

Director of Education in Delft

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Director of Education in Twente

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Programme Developer 4TU-CME

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Study Advisors at the three locations

Study Advisors in Delft

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E-mail: p.desmidt@tudelft.nl

Study Advisor in Eindhoven

Mrs. J.A.M. (Josée) Pulles
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Study Advisor in Twente

Ir. J. (Judith) Roos-Krabbenbos
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E-mail: j.roos-krabbenbos@utwente.nl

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.dr. 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: Ing. K.M. van Zuilekom
- 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 (Construction Management and Engineering)
- Advisor: Dr.ir. C.M. Dohmen-Janssen (director of education)
- 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
- Member: Dr.ir. L. Volker
- Student member: Rik Tersteeg
- Secretary: M.H. van Vollenhoven-Geldof

Education Committee in Eindhoven

Members of the Education Committee in Eindhoven:

- Chairman: Dr.ir. S.P.G. Moonen
- Member: Dr. Q. Han (CME)
- Member: Dr.ir. M.G.L.C. Loomans
- Member: Ir.ing. F.J.M. Luijten (ABP)
- Member: Ir. R.A. Rutgers
- Member: Dr.ir. H.A.J.A. Appel-Meulenbroek
- Student member: M. Stancheva (CME)
- Secretary: Mrs F.M. Clijsters (VRT 2.I05) f.m.clijsters@tue.nl - 040-2472711

Education Committee in Twente

Members of the Education Committee in Twente:

- 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: E. Berghuis
- Student member: R.J. Daggenvoorde
- Student member: H.J. Drenth
- Student member: H.B. Koopmans
- Student member: R.L.T. Oppers
- Advisor: Dr.ir. C.M. Dohmen-Janssen
- Advisor: S. Siebelink MSc
- Advisor: D.E.C. Blomjous
- Secretary: Drs. E. Ruijgh

STUDY ASSOCIATIONS AT THE THREE LOCATIONS

STUDY ASSOCIATION IN DELFT

Study association CME Dispuut
Building 23, Room 3.53
Postbus 5048
2600 GA Delft

Location
Stevinweg 1
Building 23, Room 3.53
Phone: 015-2785012
E-mail: info@cmedispuut.nl
Website: www.cmedispuut.nl/

STUDY ASSOCIATION IN EINDHOVEN

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

Location
Vertigo floor 8
Den Dolech 2
Telephone: 06 18 97 20 81
E-mail: info@ofcoursecme.nl
Website: www.ofcoursecme.nl

STUDY ASSOCIATION IN TWENTE

Study association ConcepT
Studievereniging ConcepT
Horst (basement) C-016 and C-018
Postbus 217
7500AE Enschede

Location
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Drienerlolaan 5
Phone: 053 489 3884
E-Mail: ConcepT@ConcepT.utwente.nl
Website: www.concept.utwente.nl

Alumni Associations at the three locations

Alumni Association in Delft

CME Dispuut
Building 23, Room 3.53
Postbus 5048
2600 GA Delft

Location
Stevinweg 1
Building 23, Room 3.53
Phone: 015-2785012

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

Alumni Association in Eindhoven

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

Email: info@ofcoursecme.nl
Website: www.ofcoursecme.nl
LinkedIn: https://www.linkedin.com/groups/126804

Alumni Association in Twente

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

Email: concreet@utwente.nl
Website: https://www.concept.utwente.nl/praktijk/concreet
LinkedIn: www.linkedin.com/groups/55115

COMPULSORY COURSES AT THE THREE CME LOCATIONS

The study programme is composed as follows:

a. Core programme (compulsory courses), 28 – 37.5 EC
b. Specialism-related courses and electives, 50 – 56 EC
c. Graduation work, 36 – 40 EC

COMPULSORY CORE COURSES IN DELFT (28 EC)

Corner stones (28 EC)				
Course Code	**Name**	**Period**	**Responsible lecturer**	**EC**
AR8002TU	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
Obligatory specialism-related courses (31 EC)				
Course Code	**Name**	**Period**	**Responsible lecturer**	**EC**
EPA1432	Cross-cultural Management	1	Prof.dr. W.M. de Jong	5
CME2300	Financial Engineering	1	Ir.drs. J.G. Verlaan	4
CIE4030	Methodology for Scientific Research	1,2,3,4	Prof.dr.ir. H.E.J.G. Schlangen	3
CIE4130	Probabilistic Design	2	Dr.ir. O. Morales Napoles	4
CME1210	Infrastructure Asset Management	4	Dr. R. Schoenmaker	7
CME2200	Dynamic Control	4	Dr.ir. M.G.C. Bosch-Rekveldt	4
WM0312CIE	Philosophy, Technology Assessment and Ethics	4	Dr.mr.ir. N. Doorn	4

COMPULSORY COURSES IN EINDHOVEN (30 EC)

Course Code	Name	Period	Responsible lecturer	EC
1CM900	Project Management	2	Dr. W.L. van Jaarsveld	2.5
1ZM65	System Dynamics	4	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 (30 EC)

Course Code	Name	Period	Responsible lecturer	EC
195820400	Research Methodology and Academic Skills	2	Dr.sc.techn. A. Hartmann	7.5
And at least 3 of the following 4 courses:				
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
195800100	Legal & Governance Aspects	1	Dr. P.J. Klok	7.5
195800200	Project Management	2	Dr. S.H.S. Al-Jibouri	7.5

OVERVIEW OF THE COURSES IN DELFT

COMPULSORY CORNER STONE COURSES IN DELFT

Legal & Governance	
Responsible lecturer:	Mr. F.A.M. Hobma
Course code:	AR8002TU
Period:	1
ECTS:	7

Course description:

This course holds two parts: a legal part and a governance part.

- Legal part: the planning and construction of buildings and infrastructure is surrounded by many legal issues like procurement, contracts, permits etcetera; the main legal aspects involved in the planning and construction of works of civil engineering nature will be discussed. Main topics include: contract law, Dutch and FIDIC conditions, European and Dutch procurement law, arbitration and dispute review, planning law, European environmental law, the Infrastructure Planning Act, land assembly, permits; the themes will be illustrated using real cases from Holland and abroad.
- The governance part is about actors in construction industry and their behaviour; networks, markets, hierarchy, public private partnerships.

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. Projects, in all contemporary industry sectors and specifically in construction, are becoming increasingly complex and challenging with the accelerated advances in technology, new business models, forms of collaboration, availability requirements, and an augmented demand to deliver economic value and a competitive advantage. Managing projects in this environment 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.

The course provides a thorough exploration of project management processes and tasks. These include Project organisation, Planning tasks and control strategies, Contracts and procurement methods, Communication and inter-relationships between project stakeholders.

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. An environment that is influenced by various social, political and physical factors. These actors may be related to a project in various ways, e.g. as decision makers, regulators, risk taking participants and stakeholders, 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)

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. In most cases:

1) the state of the environment (politics, stakeholders, regulations, etc.) at the start of a project is totally different from the state of the environment during the project, at the end of the project and certainly during the operation phase during the lifetime of the system,
2) the information and knowledge about the desired system in its environment increases dramatically during the project, which leads to different views and options and
3) the state of the technology to be applied in a project changes during a project.

In consequence, we often develop systems with the ideas of yesterday and with today's technology for tomorrow's people.

To create value, we should not only work dynamically in an adaptive way with continuous change, but also take care that the systems we deliver are 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 to play with complexity; allow for more dynamic approaches in project management and to strive for solutions that maximize value. Sustainability is a key issue.

After this course you are able to:

- Explain the dynamic character of a project, a product and a process,
- Perform a complexity assessment on a real life project, both individually and with a group,
- Recognize the relations between complex project systems and higher scale (context)systems,
- Apply methods to deal with the effectiveness and efficiency of projects in a changing world,
- Choose management approaches to deal with different types of project complexity,
- Describe the advantages and disadvantages of innovative ways for collaboration and contract types in complex environments.

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.

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.

After this course, for a given asset management problem, students will be able to:

- Choose, apply and evaluate the most appropriate mix of methods, techniques and tools for tackling the problem;
- Look at the problem from various viewpoints and apply this in tackling the problem.

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.

The intended learning outcomes of this course are:

- To give students a knowledge of financing and financial implications of civil engineering projects from both a firm and a project perspective, including perspectives from financial involved actors;
- To give students an understanding of the project life-cycle and its impact on and relationship with project finance;
- The ability of students to deal with uncertain political and social factors and financial risks.

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.

Study goals:

- To be able to clearly describe a research goal.
- To be able to design a scientific research.
- To be able to analyse the results of a scientific research.
- To be able to formulate the structure of a scientific report

The course will be given with Online-lectures.

Cross-cultural Management	
Responsible lecturer:	Prof.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.

The main objective is that students are able to argue for specific strategies for dealing with cross-cultural issues in organisations and policy/organisational transplants

To do this well, the students are also able to:

- Apply different perspectives on globalisation
- Discover cultural dimensions in given social/organisational phenomena and events
- Identify an appropriate attitude towards cross-cultural collaboration and communication in given cultural contexts
- Identify successful and unsuccessful social/organisational structure and behaviour in given cultural contexts
- Analyse how institutions (policies, organisations) might be transplanted successfully 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. It consists of three modules:

Philosophy Module

- What is science, and what is technology? Brief overview of their history; positions on the influence of science and technology on society;
- The fact/value distinction; logic and argumentation theory;
- Methodology: foundations of scientific and technological knowledge; role of scientific explanations.

Technology Assessment Module

- Why does technology fail? Technology Assessment as bridging the gap between society and the engineering community;
- Introduction to TA-methods and traditional forecasting: extrapolations, experts interview and the 'common sense'-method, scenario's, scenario workshops;
- Drivers of technological change, the relation between technological change and society
- Constructive Technology Assessment, participatory technology development;
- Practice of TA; politics, steering technological innovation of Sustainable Development.

Ethics Module

- Introduction to moral dilemmas in engineering practice;
- Analysis of moral dilemmas in engineering practice and their backgrounds; professional codes of conduct and conflicting loyalties; legal rights and duties of engineers;
- Ethics, i.e. the foundation of judgments about good and bad / responsible and irresponsible acts;
- Introduction to some topics especially relevant for engineering: risks, responsibility and sustainability.

ELECTIVE COURSES IN DELFT

The CME degree programme has four specialisations and a free study programme
a. Asset Management
b. Infrastructure and Environment
c. Project Management
d. Legal and Finance
e. Free study programme
Students who have opted for a specific specialisation must choose electives from the lists below.

Specialisation Asset Management (AM)		
Course code	**Name**	**EC**
CIE3380	Infrastructure Management	4
CIE4120	Information Systems for the Construction Industry	4
CIE4480	Integral System Design	4
EPA1332	Discrete Systems Modelling	5
IN4086	Data Visualization	6
IN4152	3D Computer Graphics and Animation	5
SPM4410	Designing Multi-Actor Systems	6
WI2608	Optimization	6
WI4050 6	Uncertainty and Sensitivity Analysis	6
WI4138	Decision Theory/Expert Judgement	6
Students may choose 1 out of:		
CIE4061	Multidisciplinary Project	10
CIE5050-09	Additional Graduation Work	10
CME2100	Internship	10

Specialisation Infrastructure and Environment (IE)		
Course code	**Name**	**EC**
AR0027	Smart Infrastructure and Mobility	6
CIE4760	Assessment of Transport Infrastructure and Systems	6
SPM9750	Environmental Sustainability in the Built Environment	4
Students may choose 1 out of:		
CIE4061	Multidisciplinary Project	10
CIE5050-09	Additional Graduation Work	10
CME2100	Internship	10

Specialisation Project Management (PM)		
Course code	**Name**	**EC**
CIE5720	Environmental Impact Assessment	4
CIE598	Forms of Collaboration in Civil Engineering	4
EPA1143	Actor and Strategy Models	5
SPM4410	Designing Multi-Actor Systems	5
SPM9155	Advanced System Dynamics	4
SPM9537	Integrated Plant Management	5
Students may choose 1 out of:		
CIE4061	Multidisciplinary Project	10
CIE5050-09	Additional Graduation Work	10
CME2100	Internship	10

Specialisation Legal and Finance (LF)		
Course code	**Name**	**EC**
AR0880	Real Estate Valuation	7
CIE4760	Assessment of Transport Infrastructure and Systems	6
SPM4423	Legal Aspects of Multi Actor Systems	5
SPM9715	Intermediate Economics	5
SPM9716	Cost-Benefit-Analysis: Theory and Applications	4
WI3421	Risk Management	3
Students may choose 1 out of:		
CIE4061	Multidisciplinary Project	10
CIE5050-09	Additional Graduation Work	10
CME2100	Internship	10

Free specialisation		
Course code	**Name**	**EC**
Students who have opted for the free specialisation must choose elective courses in conjunction with the CME degree.		
Students may choose 1 out of:		
CIE4061	Multidisciplinary Project	10
CIE5050-09	Additional Graduation Work	10
CME2100	Internship	10

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 are discussed and analysed in the lectures for further implementation by students in the assignments.

Environmental Impact Assessment	
Responsible lecturer:	Ir. P.B.L. Wiggenraad
Course code:	CIE5720
Period:	4
ECTS:	4

Course description:
The full course should provide

- knowledge and insight in scope of environmental problems on different levels, its scientific backgrounds and approaches, tools available to tackle them and their administrative and juridical backgrounds and the involvement of (civil) engineers,
- knowledge and insight in risk analysis, especially related to external safety in transport,
- knowledge and insight in aim, procedure, methodology and value of Environmental Impact Assessment (EIA),
- insight in the crucial steps and elements in the EIA process,
- ability to review and cooperate in drafting an Environmental Impact Report (EIR).

Information Systems for the Construction Industry	
Responsible lecturer:	Dr.ir. G.A. van Nederveen
Course code:	CIE4120
Period:	1
ECTS:	4

Course description:
This course contains Information theory 1) BIM concepts, 2) Parametric Design and Interoperability, 3) Life Cycle Information Systems concepts: network approach, asset and maintenance information management, 4) Use of common systems in construction projects, such as Revit, Navisworks, Relatics and Maximo, and 5) Role and importance of BIM and Life Cycle Information Systems in Construction Projects and Organizations.

Open Design and Construction Management	
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.
The tools and concepts offered are complementary to the traditional ones as recommended in the mainstream of project management literature.

Students are requested to apply the offered tools and concepts in a real-life construction project of their own choice. Foreign students are free to select a project from their home country.

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.
The following subjects will be dealt with:
- principles of an agreement and the elements that play a role in collaboration are discussed
- the control of a project in relation to collaboration forms
- the contract and the corresponding components such as tasks, responsibilities and authorities
- the systems of reimbursement as a function of contract form
- risks, risk distribution, risk management, in various contract forms
- the family of: design & construct, DBM, DBMOT, DBMFOT, partnering, alliances, public private partnership
- practical examples illustrated by visiting lecturers
- foreign forms of collaboration
- the selection and choice of a contract partner
- new development in different countries.

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. Traditionally there were only very little opportunities to introduce the market mechanism in infrastructure sectors like transport, telecom or energy. However, as a consequence of technological developments and innovative means of economic organization, a broad development of liberalization of different kinds of infrastructures evolved. The economic consequences will be addressed, both with respect to the industrial organization and the changing public management. An interdisciplinary approach is necessary to cope with the complex technical, political and economical 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.

Real Estate Management	
Responsible lecturer:	Ir. M.H. 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, for example ABN AMRO, Philips, the Dutch Government, the European Commission, AKZO Nobel, MasterCard or a university. Relevant questions are for instance: what type and quality of buildings do the users want and need? What are the organisation's goals and how can real estate support these goals? Which resources are available for real estate? What is the present condition of the buildings and what is the effect on users, resources and goals?

Actor and Strategy Models	
Responsible lecturer:	Dr.ir. L.M. Hermans
Course code:	EPA1143
Period:	2
ECTS:	5

Course description:
In this course, students learn to analyze and explain behavior of actors in processes of policy and strategy-making. Students will be able to use several model-based approaches for actor analysis, and to reflect on the usefulness of these methods in a given situation.
The course "Actor and strategy models" provides students with a range of models and analytical lenses to understand actor interactions and strategic behavior in actor networks. A generic framework for such analysis is offered, introducing core concepts used for actor analysis. Different methods for actor analysis, focusing on different core concepts, are covered.

Designing Multi-actor systems	
Responsible lecturer:	Dr. S.G. Lukosch
Course code:	SPM4410
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. Thereby, the course provides students with a background for working with designers from different disciplines and they becomes familiar with the specific SEPAM-perspective on designing multi-actor systems.

Risk Management	
Responsible lecturer:	Dr. P. Cirillo
Course code:	WI3421TU
Period:	2
ECTS:	3

Course description:
The course will cover the main topics of risk analysis and management for banks, insurance companies and financial institutions. The main economic and financial risks will presented, analyzed and estimated using the state-of-the-art techniques available in the literature and used by practitioners. For every tool a discussion about its weaknesses and strengths will be given.
The course is meant to provide the students with a broad basic knowledge of risk management issues and is designed to integrate the topics taught in the other courses.

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. During the course, the students will simulate that they belong to the planning board of a new airline company that will start to operate under a competitive environment. This practical simulation will involve the fleet, network and airline scheduling planning processes over a fixed period of 3 years.

At the end of the course, the students should be able to:
- Obj1: differentiate distinct airline business models, identifying their respective network structures and fleet management strategies;
- Obj2: develop an airline strategic plan consistent with a specific business model;
- Obj3: compute key performance indicators in a network perspective;
- Obj4: develop modeling techniques to support the decision-making process

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 two aspects: 1. Recent technological developments and application of ecosystem functions and 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.

In the course 5 main subjects are covered, these are:
- Sustainability and Ecological Engineering theories and concepts
- Civil Engineering practices and their environmental effects
- Ecosystem functioning and potential for application in civil engineering practices
- Tools to quantify sustainability performance on different scale levels
- Examples of TUD research in which theories and concepts of ecological engineering is brought into practice in order to improve sustainability performance 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.
Upon successful completion of this subject, the student should be able to:

1. To identify the basic elements such as project characteristics, control systems, methodology and supporting systems in an integrated design process for concrete structures;
2. To identify characteristics dictating the way a concrete building project is being managed in practice and emphasis on the methodology to be adopted when worked out;
3. To optimise the process of design and construction in terms of costs, time and maintenance in selecting a construction process, a construction schedule and investment in temporary works;
4. To develop a design methodology in which cost aspects regarding repetition effect, investments in type and amount of formwork and schedules of levelling labour force are being dealt with;
5. To demonstrate actions which can be taken to control the design process and to assure the quality of the engineering process and the construction process;
6. To generate different design concepts and to select one of them in view of costs, execution time and durability;
7. To implement all these aspects in a case study.

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 two goals of the course are, first, to understand Complex Adaptive Systems theory and its relation to the socio-technical systems around us. Second goal is for the student to learn about the basics of Agent Based Modeling.

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.

Upon completion of this course the student will have knowledge of:

- the possibilities and limitations of the System Dynamics modelling method;
- the relevant scientific literature on selected topics in the field of System Dynamics such as the use of data, model structure and behaviour, model validation under uncertainty, serious gaming with System Dynamics, group model building and exploratory model analysis.

The student will have the skills:

- to make an informed choice as to when to use System Dynamics;
- to apply the theoretical knowledge on building, validating and communicating models in a problem situation;
- to understand current literature and recent advances in the field of System Dynamics.

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.

Study goals:

- understanding the management tasks in a manufacturing company.
- understanding how are they executed and who bears the responsibilities.
- determining possibilities for improvements of individual management tasks. To execute an improving a project according to the Lean Six Sigma approach.
- making a conceptual design of an integrated management structure in the MES (Manufacturing Execution System)-environment.

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. The course applies principles from previous courses with respect to control, management and governance to the area of risk and safety. It provides studenst with strengths and weaknesses of methods and techniques in problem analysis and problem solving at various systems levels and from different perspectives based on the notion of integral safety. The course focuses on applying basic skills in accident analysis, quantitative risk assessment and the design of complicated problem solving strategies.

Integral Systems Design	
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.
The lectures have a "flip the classroom" format: every week students are asked to read specific chapters, prepare a short presentation and submit discussion questions. The lecturers give feedback, act as discussion moderator and give introductions to new chapters.

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 Financial analysis, Cost benefit analysis, Multicriteria analysis, Travel cost impacts assessment, Environmental and ecological impacts assessment, Safety impacts assessment, Land use impacts assessment, Social impacts assessment, Usage of assessment results in planning process.
Case studies: 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).

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 will concentrate on the most challenging part of uncertainty analysis: dependence modelling. In particular, on copula models and their applications in finance and insurance. We will discuss the theory of copulas and their use in regression, time series analysis and factor models. After this course, students must be able to explain on their own examples concepts such as: uncertainty, independence, and dependence. They should understand proofs of basic properties of different dependence measures and dependence models. In particular students should be able to apply concepts us univariate and multivariate uncertainty distributions, copulas, graphical models. They should be able to justify which model should be used in the particular situation and explain what are pluses and minuses of different constructions from the applied point of view.

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

Course description:
This course contains 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. The data sets can be results of numerical simulations or measurements (scientific visualization), or other data collections such as large databases (information visualization). The goal is to improve insight, understanding and/or communication of data.
The goal of the course is to get knowledge on the basic fundaments that are part of data visualization. The main principles and techniques that are the basis of generating effective visual representations of data.

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:
Cost-benefit analysis (CBA) has become a widely used (often mandatory) tool for public policy decision making on infrastructural projects or environmental and climate policies. Through CBA, the potential current and future gains and losses of a proposed policy are identified, and then converted into monetary units in order to make them comparable with policy alternatives; certain decision rules help determine whether the project is desirable from society's standpoint. Because CBA evaluates policy and/or project proposals from the point of view of the public interest, the market prices used in CBA are corrected for possible market distortions or failure (for example, un-priced environmental damage). Nevertheless, the application of CBA is fraught with difficulties and limitations that need to be taken into account.

Intermediate Economics	
Responsible lecturer:	Dr. C.W.M. Naastepad, Dr. S.T.H. Storm
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:
Runway extension, construction of works in protected areas, subsidizing sustainable projects... they all happen within a design space, limited amongst others by legal rules and requirements. To make optimal use of the design space, you have to know about these rules and requirements. 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.ir. A. Straub
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. It starts with building and renovation processes, its stakeholders and decision-making. Next energy demand and supply, energy distribution and conversion, health and comfort of users, life cycle assessment, life cycle cost analysis and the economics of sustainable renovation (business case) are discussed.

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 metropolitan area of São Paulo is comparable to the Randstad in terms of size and economic output, but has twice its population. The complexity of planning and designing for traffic and water resilience in a metropolis of a developing economy context poses challenging questions. 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.
The main objectives are

- to develop your general engineering skills,
- to develop your research skills,
- to learn how to apply your technological know-how,
- to put into practice any social and communicative skills you might have,
- to gain a more complete insight into your own particular aptitudes.

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.
The course is divided into three phases: phase 1: inception plan; phase 2: preliminary design and studies; phase 3: process evaluation with respect to interdisciplinary aspects; final report.

Additional Graduation Work	
Responsible lecturer:	Ir. J.W. Welleman
Course code:	CIE5050-09
Period:	1,2,3,4
ECTS:	10

Course description:
Additional Graduation Work may or may not be related to the MSc Graduation Work, but it must, in any case, be separately distinguished. The content of the project is defined by the appointed examiners. Suggestions may come from students as well.
The study goal is a demonstration of ability to perform research at an academic level.

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
Specialisation 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	2
Entrepreneurial Marketing	5	2
Built Environment and Smart Mobility	5	4
Research and Development Project	10	1,2,3,4
Big data and experiments for urban analysis	10	3,4
Urban Planning II	5	1
Free Electives course (15ECTS)		
All 4TU-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. W.L. van Jaarsveld
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:	4
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:	2
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.
The main deliverables in the course are focused on identifying and testing the key factors that help you decide if a (technology based) idea is a real opportunity and validate and adjust the idea in the market. Therefore, identifying, defining, and understanding the market and all relevant stakeholders is a cornerstone of the course. Equally important, however, is investigating whether the idea is an opportunity for you. To answer that, you need to understand who you are and what you want, particularly in relation to the idea and the decision making process needed to further develop this idea. This course is designed to help you do that through a thoughtful and active exploration of the decisions you will make and the experiences you will encounter in pursuing an idea to its fulfillment.

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:	Dr. 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:	Dr. G.Z. Dane
Course code:	7ZM1M0
Period:	1,2,3,4
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:	Dr.ir. A.D.A.M. Kemperman
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 (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.
- The first method (A) is the stated preference/choice approach and can be used for measuring individuals' preference and choice behaviour for new, not yet existing, alternatives.
- The second approach (B) uses information from a big database such as GPS data or one of the large national surveys, such as OVIN and WOON.

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

Course description:
This course is of importance to everyone applying building information technologies in practice, developing novel ways to address current and future challenges in ICT-supported collaboration in building and construction and doing fundamental research in the field. In order to model such information, the student learns to model using tools like the visual modelling language UML (Unified Modelling Language). UML is used as the "stepping stone" to translate data models created by other diagram techniques. The student learns to read and to interpret such models created with different diagraming techniques. The student also learns to read and created models as a basis for new insights.

Urban Planning II	
Responsible lecturer:	Ir. A.W.J. Borgers
Course code:	7ZW3M0
Period:	1
ECTS:	5

Course description:

This course is about planning of retail and public facilities in urban areas. It also deals with population and housing demand forecasting and predicting the development of urban areas.

The course starts with a short introduction into spatial planning in the Netherlands and Europe. The next part deals with planning retail facilities and public facilities, both in terms of supply and demand. Retail facilities will be discussed at the level of urban areas and at the level of shopping centres. Small groups of students compare and assess facilities in different urban areas. The last part of the course is about predicting the development of urban areas. Methods to predict the size and composition of the future population and the corresponding housing demand, as well as so called land use models are introduced. Students will gain experience with such methods and models.

ELECTIVE COURSES IN EINDHOVEN

Architecture and philosophy	
Responsible lecturer:	dr. J.C.T. Voorthuis
Course code:	7QX6M0
Period:	3
ECTS:	5

Course description:
Through the concrete examination and critique of specific buildings, designs and urban agglomerations from a specific point of view, you will, at the end of the course, be in a position to place your own efforts in design and design thinking within an increasingly refined and well-practised frame of reference, helping you to make considered design decisions within social space and thereby undertake and undergo the odyssey of the design process with greater awareness.

Architectural analysis	
Responsible lecturer:	Dr. Dipl.-Ing. H.H. Yegenoglu
Course code:	7QX7M0
Period:	4
ECTS:	5

Course description:
The key purpose of the course is to develop academic and critical approach in the field of architectural analysis. In this course, students gain knowledge in different comparing methods concerning the analysis of buildings. Furthermore, they gain insight into the spatial structure of complex buildings, like schools, theaters, prisons and hospitals, as well as their theoretical and historical context.

Urban Form	
Responsible lecturer:	Dr.ir. A.H.J. Bosman
Course code:	7QX8M0
Period:	3
ECTS:	5

Course description:
The aim of the research – as practiced in this course – is being able to relate more consciously 1. architectural theory on meaning (in what way does architecture represent ideas?), to 2. urban design theory on typo-morphology (the way building blocks define an urban tissue). And applying such insights to a real situation (case study Parkstad, a conglomeration of cities in the south of the Netherlands). This research is not only important for being able to better relate architectural and urban design theory, but as well in order to come one step further in the debate on (and practice of) urban typo-morphology.

Smart Cities	
Responsible lecturer:	prof.ir. E.S.M. Nelissen
Course code:	7LY8M0
Period:	3
ECTS:	5

Course description:
In this course, students:
- gain/acquire knowledge of state-of-the-art smart cities technological/ research.
- gain knowledge about methods for analysis (CiD)
- gain knowledge about methods for creating a business proposition (Canvas Business model)

Constructing architecture	
Responsible lecturer:	Ir. M.H.P.M. Willems
Course code:	7QQ2M0
Period:	3
ECTS:	5

Course description:
Contemporary architecture unfolds a huge variety of different thematic emphases, design approaches and forms of materialisation. By inviting selected design practitioners ' Constructing Architecture' explores a range of different architectural design projects of contemporary architecture. While it is impossible to force these distinct architectural projects into neat and unambiguous categories or styles, this course attempts exploring selected projects through a number of 'themes' that were central to designing these projects. Based on a broad understanding of constructing we retrace through selected case studies how architectural projects were made in non-linear and contingent design processes that were shaped through heterogeneous elements for instance interests, choices, building regulations, aesthetic preferences, costs, different scales, timeframes, materialities, etc.

Theory and practice of the public domain	
Responsible lecturer:	Dr. S. Krishnamurthy
Course code:	7QW7M0
Period:	1
ECTS:	5

Course description:
This interdisciplinary course examines public spaces as physical and social constructs created over time. The lecturers will try and answer through themes how can these spaces of congregation, occupation and circulation can be defined, analysed, visualized and sometime improved.
By using cases from the Netherlands, participants are exposed to spatial planning histories, organisational scales, spatial and decision making challenges, and available urban resources for redesign.

History of housing and cities	
Responsible lecturer:	S.S.S. Rousseau D.P.L.G.
Course code:	7ZW6M0
Period:	3
ECTS:	5

Course description:
The lecture combines chronological and comparative approaches. The content covers the historical evolution of the social housing production in Europe, from the early nineteenth century until nowadays. Each lecture is related to a specific type of actor. The ambitions, the tools and the power of the actors are presented and related to their urban physical influences. Each lecture presents examples of housing estates, from the same type of actors, in different countries, and compares them.

Sports and building aerodynamics	
Responsible lecturer:	Prof.dr.ir. B.J.E. Blocken
Course code:	7LL1M0
Period:	2
ECTS:	5

Course description:
Can the present outstanding records in cycling team time trials be further improved? Can the present world and Olympic records in athletics disciplines such as the 100 m sprint be advanced? This course provides the answer to these questions. It shows that aerodynamic processes in sports and around buildings are very complex and that many misconceptions exist. These misconceptions are caused by the often counter-intuitive flow physics. Interestingly, the same counter-intuitive flow physics govern the misconceptions in both sports and building aerodynamics. The insights from this course will help you to understand and improve the performance of top athletes and of modern building design.

Urban Trends	
Responsible lecturer:	ir. A.W.M.M. de Bont
Course code:	7QX9M0
Period:	4
ECTS:	5

Course description:
How do social, political and economic developments impact on the disciplines of urban design and planning, the profession, the spatial strategies and the current topics. This course gives insight into the clear relation between the social context in a broad definition and the discipline of urbanism. This involves looking back at a number of important key periods in which the relation between the political and economic context, the resulting social challenges, and the consequences for urban discipline in terms of tasks and instruments is clear.

Architectural expression	
Responsible lecturer:	Ir. R.P.G. Brodruck
Course code:	7QQ1M0
Period:	1,2,3,4
ECTS:	5

Course description:

1. Development of knowledge and understanding of:
   1.1 the manifestation of a building or artefact regarding its construction
   1.2 The visual art(s) in relation to the architectural design.
2. Development of skills to enable students in:
   2.1. Generating and constructing a tectonic concept.
   2.2. Expressing a tectonic concept through different media.

Building Methodology and Technology – Certificate course BD&T	
Responsible lecturer:	Prof.dr.ir. M. Mohammadi
Course code:	7KP8M0
Period:	3
ECTS:	5

Course description:

This course aims at expanding the intellectual horizon of students regarding building methods and technological possibilities. To achieve the objectives of this course the theoretical approaches and principles, outlined in the weekly lectures, are reinforced by the knowledge of the latest technologies applied in the field of building engineering. (Guest) Lecturers will also provide an overview of recognized building principles and methods (e.g. active house, passive house, open building and experimental buildings) and will discuss the state-of-the-art of technologies in architectural design (e.g. building automation, robotics, virtual reality and augmented reality).

Master project construction plan - Certificate course CT	
Responsible lecturer:	Ing. C.M. de Bruijn
Course code:	7RC50
Period:	4
ECTS:	5

Course description:

In the course the student learns to apply constructional and structural knowledge when solving a specific problem that occurs in a building under construction.
During this process the student learns:

- to analyze a problem in terms of cause and effect
- to think in added value and optimizing related to time and costs
- to generate various solutions for this problem and time/costs estimations
- to compare these solutions and to motivate the subsequent choice
- to work out and to pitch and present this solution
- to write an fully developed academic paper about the subject

Masterproject Building Technology – Certificate course BD&T	
Responsible lecturer:	Prof.dr.ir. M. Mohammadi
Course code:	7KS1M0
Period:	1
ECTS:	5

Course description:
In this project the knowledge and skills developed through the two courses " Building Methodology and Technology " and " Building Technology with Extreme Complexity " will help students to better understand the nature of building technology and to realize innovative and qualitative architectural concepts and products.
During 8 weeks students will carry out a research aiming at designing an innovative building or developing a building product, in order to improve cases in the fields of health & well-being, ecological sustainability or building for developing countries.

Building Technology with Extreme Complexity - Certificate course BD&T	
Responsible lecturer:	Prof.ir. J.D. Bekkering
Course code:	7KP9M0
Period:	4
ECTS:	5

Course description:
This course is designed to provide students with knowledge on a number of design issues regarding large and complex buildings. Several complex buildings will be discussed in the weekly (guest) lectures from different points of view such as site, form, structure, skin, building services, space plan and materialization.
The complexity of design processes, diversity of aims and disciplines and necessity of an integral approach will be discussed.

Practical assignment bouwkundewinkel	
Responsible lecturer:	Dr.ir. S.P.G. Moonen
Course code:	7KS3M0
Period:	1,2,3,4
ECTS:	5

Course description:
The Practical Assignment Bouwkundewinkel always relate to a question from a real practical problem, since the Bouwkundewinkel receives many requests from practice to solve an existing problem or to generate ideas for a new practice. Some of the requests regard imperfections or even failings, but there are also many requests regarding all kinds of design issues.
The Bouwkundewinkel translates the practical request into an assignment for students, and contacts a specialized teacher. Together with the teacher, a study plan will be prepared. Often, the client will be asked to provide additional information.

Time, costs, methods and equipment - Certificate course CT	
Responsible lecturer:	Ing. C.M. de Bruijn
Course code:	7RC80
Period:	1
ECTS:	5

Course description:
During the course the following subjects will be given: Vertically and horizontally concrete works, Construction of high-rise buildings, Formwork and regulations, Cranes, Optimal Site Transportation, Logistics Process Analysis, Logistics in the façade-, roof- and finishing phase, Construction site planning and accessibility, Composition of a Transport Plan, Calculating Construction costs and General Site Costs, Logistics in urban locations.

Heritage, urbanization and global efficiency	
Responsible lecturer:	dr. A.R. Gomes Mendes Martins Pereira Roder
Course code:	7QW8M0
Period:	1
ECTS:	5

Course description:
Along the lectures, students will focus on the themes: Global Efficiency; Sustainable Urbanization; expansion and transformation; Environmental Management; Heritage Conservation – natural and cultural; Impact Assessments; (Retrospective) Heritage Impact Assessment.

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:

The MSc. Education program `Construction Management & Engineering (CME) at TU/e is a joint international Master-program of the three Dutch Universities of Technology. At TU/e the graduation specialization of CME consists of `Construction Management & Urban Development' (CMUD). The final graduation project has a clear scientific signature, and is grounded in actual CMUD challenges. CME graduation projects are often executed in collaboration with industry partners, engineering offices or government institutes. CMUD borrows from two scientific domains: (i) urban science and systems and (ii) management and innovation sciences.

Graduation options

The graduation project is executed across of the two aforementioned scientific domains. Within this cross section students can choose from a list of subjects that are strongly related to on-going projects in the TU/e departments Built Environment (BE), and Industrial Engineering and Innovation Sciences (IE&IS). All subjects are clustered into the following research areas:

- Process engineering:
  When cities or urban districts are to be developed or redeveloped, complex decision-making and information processes are needed in order to bring shareholders and stakeholders together. Developing models for negotiation, data management, simulation of expected results and process governance are the focus of these graduation projects.
- Business engineering:
  Cities and urban districts are considered and approached in terms of entrepreneurial entities: profit and non-profit companies. In the individual graduation projects, the subjects are value features, exploitation possibilities, management and financing concepts.

For both research areas the following relevant societal and engineering topics, regarding smart city development are in focus:

- Energy management
- Urban management
- Information management

During the graduation project students will learn to make scientific analyses for complex technical and/or managerial problems. They can model these problems using state-of-the-art modelling techniques and their knowledge on technical systems, urban environment and management theories. The students are skilled in scientific publication of the problem analyses and model outcome and they can present of the results to a wide audience.

OVERVIEW OF THE COURSES IN TWENTE

PROGRAMME OVERVIEW

Profile: Markets and Organization in Construction	**Profile: Design Management in Construction**
Compulsory profile courses (30-37,5 EC)	**Compulsory profile courses (30-37,5 EC)**
- Research Methodology & Academic Skills And at least 3 of the following 4 courses: - Planning and Process Management - Collaborative Design and Engineering - Legal & Governance Aspects - Project Management	- Research Methodology & Academic Skills And at least 3 of the following 4 courses: - Planning and Process Management - Collaborative Design and Engineering - Legal & Governance Aspects - Project Management
Elective profile courses	**Elective profile courses**
CEM-courses that fit best in this profile: - Supply Chain Management and ICT - Markets, organizations and Innovations - Procurement Strategies and Tendering - Infrastructure Management Courses from other programmes that fit in this profile: - Organization & Strategy - Cost Management and Engineering - Supply Chain & Transportation Management - Maintenance Engineering and Management - Reliability Engineering & Maintenance Management	CEM-courses that fit best in this profile: - Sustainable Building - Building Information Modelling and 5D-planning - Project Control and Risk Management - Industrialization and Innovation in Construction - Infrastructure Management Courses from other programmes that fit in this profile: - Cost Management and Engineering - Maintenance Engineering and Management - Reliability Engineering & Maintenance Management - Advanced Production Planning - LEAN Six-Sigma Green Belt
Electives (maximum 15 EC) - Any course from UT or approved other university*	
Thesis (37,5 EC) - Preparation MSc-thesis (7,5 EC) - MSc-Thesis Project (30 EC)	

* an "approved university" is any university in The Netherlands (not HBO-schools), or any international university that is partner of the UT or of the faculty of Engineering Technology
For a list of partner universities, see: https://www.utwente.nl/ctw/student-mobility/partners/
For courses from other universities: contact your track-coordinator.
The Free Electives should be at MSc-level and should have no overlap with other courses in your programme.

COMPULSORY COURSES IN BOTH DOMAINS

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

Course description:
While working on assignments/projects or their master thesis many students face the challenge to define a research problem, design a research strategy, and execute the research plan. In these assignments the students often have to relate a real world problem to theory and literature from the field of construction management and engineering to come up with valid conclusions and practical recommendations.
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.

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.

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. Process Management: this part aims at providing students with basic concepts, skills, and insights needed to understand the nature of interaction between actors regarding the initiation and development of complex large-scale construction projects.

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 you in an interactive manner the skills and competencies you need for the case.

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.

ELECTIVE PROFILE COURSES

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. The course covers the development of effective maintenance and rehabilitation strategies for portfolios of infrastructure facilities as well as the planning and procurement of single maintenance and rehabilitation projects. It particularly addresses the dynamic relationship of economical, organisational and quality issues during the life cycle of infrastructure facilities.

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:
The learning goals for this course are:

- obtaining insights in the juridical & social framework, literature, and underlying economic theories related to procurement and tendering
- analysing and choosing solutions for existing procurement and tendering problems
- obtaining insights in procurement and tendering factors influencing the project strategy and client contractor relation
- creating a suitable procurement strategy for a real case In the past Design Bid Build, with design responsibility for the client, was by far the most used procurement route in the Netherlands and other western countries

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.

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

Course description:
The environmental impact of the construction industry, buildings and constructions is large. Since many years multiple parties try to address this issue. Every year more and more techniques are offered and measures are taken to lower the environmental impact. In this course you will learn how to work with the moveable target, which sustainable building is.

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

Building Information Modelling and 5D Planning	
Responsible lecturer:	Dr.ir. L.L. olde Scholtenhuis
Course code:	201400012
Period:	3
ECTS:	7,5

Course description:
The main objective of the class is to explore how state of the art information technologies support integration of project management data, both from strategic and operational viewpoint. Hands-on exploration in a practical context will show students how to using existing information modelling technologies to support project scope management with present-day tools.

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

Organization & Strategy	
Responsible lecturer:	I. Singaram
Course code:	191864610
Period:	2
ECTS:	5

Course description:
The aim of this Master-course is to provide the students with a solid and up-to-date understanding of the broad discipline of organization and strategy.
This course will address multiple perspectives on organization and strategy by giving a broad range of theories and frameworks reflecting the academic debate in the field of strategic management. The course will provide students with an up-to-date and in-depth understanding of key strategy theories and frameworks and will train students in approaching and using these theories critically. The insights of the student in organization and strategy are tested by means of group assignments and an individual written exam on the required literature and lecture notes.

Cost Management & Engineering	
Responsible lecturer:	Dr. R.A.M.G. Joosten
Course code:	201400244
Period:	2
ECTS:	5

Course description:
The course objective is to provide engineering students with the theoretical understanding and practical approaches as well as the tools and techniques for the economic and financial evaluation of stand-alone but also competing design solutions for processes, products, construction projects, services and the practical application of the approaches in more complex settings. Engineers must be able to model the economic impacts of their recommendations during the life cycle. The course will focus on monetary quantification, using different system boundaries and perspectives. Students are challenged to go out and gather information on real-life applications of cost management and engineering techniques.

Supply Chain & Transportation Management	
Responsible lecturer:	Dr. P.C. Schuur
Course code:	191820190
Period:	3
ECTS:	5

Course description:
Supply chain management is the task of integrating organizational units along a supply chain and coordinating material, information and financial flows in order to fulfill (ultimate) customer demand with the aim of improving competitiveness of a supply chain as a whole. In this course, we give an overview of the main issues in supply chain management and we pay special attention to quantitative models for three main areas within supply chain management, namely inventory allocation, revenue management, and coordination and planning and scheduling of transportation networks. Also, we discuss some new developments in supply chain management.

Maintenance Engineering & Management	
Responsible lecturer:	dr. A.J.J. Braaksma
Course code:	201200146
Period:	1
ECTS:	5

Course description:
In this course, we cover the complete process of developing a maintenance and support plan for an asset. This process starts with aligning the operation and maintenance of the asset with the strategic goals of the organization (Asset Management) and making a plan to improve the Overall Equipment Effectiveness (OEE) of an asset by making use of Total Productive Maintenance practices. This is followed by reliability predictions based on the analysis of the failure behavior. To this end, failure modes, effects, and criticality analysis (FMECA) and fault tree analysis (FTA) are used during the development phase of the asset. When new predictions are required during the exploitation phase of the asset, these analyses may be performed again, and in addition root cause analysis (RCA) can be performed.

Reliability Engineering & Maintenance Management	
Responsible lecturer:	A. Al Hanbali
Course code:	191852630
Period:	3
ECTS:	5

Course description:
In this course, we outline the main aspects related to system upkeep, focusing on balancing system availability of capital goods as mentioned above versus logistics costs during the system life cycle. Specifically, we consider techniques for reliability analysis during system design, approaches to design maintenance concepts and techniques for maintenance optimization.

Advanced Production Planning	
Responsible lecturer:	Dr.ir. J.M.J. Schutten
Course code:	191852620
Period:	4
ECTS:	5

Course description:
This course deals with a selection of complex production planning problems. It covers all levels of the hierarchical planning framework, from strategical planning, tactical planning (capacity planning and order acceptance), to operational planning / scheduling. The focus will be on the use of ILP methods and the use of queueing methods for system analysis and optimization, using recent developments in production planning research.

Lean Six-Sigma Green Belt	
Responsible lecturer:	Dr.ir. S. Hoekstra
Course code:	191127520
Period:	4
ECTS:	5

Course description:
After this course, the student is able to:
- Describe existing production processes (using the Lean Six Sigma method) and make a project plan
- Define the elements that are part of the process improvement project
- Measure current process performance and capabilities
- Analyse the results and draw conclusions about improvements to be made
- Select and implement improvement measurements that solve a problem
- Plan for sustaining achievements and quality control
- Explain how to products and processes according to the Six Sigma method

FREE ELECTIVE COURSES IN TWENTE (<15 EC)

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.

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.

Land Use and Transport Interactions	
Responsible lecturer:	Dr. L.C. La Paix Puello
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:	Prof.dr.ing. K.T. Geurs
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.

Public Transport in Urban Areas	
Responsible lecturer:	ing. K.M. van Zuilekom
Course code:	201600131
Period:	2
ECTS:	7,5

Course description:
Public Transport is crucial for the development of urban areas. PT is, when well designed, able to offer excellent mobility service from the small veins to the big arteria with a minimum need of space, resources and side effects.
Public Transport is more and more part of complex puzzle where ease of use, real-time information, other mobility services, services during travel and at the destination form an attractive versatile mobility system.
In this course PT is approached from a designer point of view where thorough knowledge of the components of the PT system (infrastructure, vehicles, safety systems, energy usage, maintenance, …), the legal context (laws and regulations), the financial aspect (exploitation costs, revenues) and the demand (modeling travel demand) form the starting point.

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.

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.

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.

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

Course description:
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.
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.

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.

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. In the project, a design is made for the implementation of quantitative water management in the catchments of the rivers Aa and Dommel and the surroundings of the city of 's Hertogenbosch.

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. 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.

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. 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 three topics are discussed that have a relation with morphology of rivers, estuaries, coasts and seas. Physics play an important role herein. Because understanding and predicting morphology is often necessary to support control, the link with practice often comes into play. An example is the widening of the Westerschelde, maintaining the coast line, controlling pipe lines in a dynamic seabed with sand waves. By means of recent scientific papers these topics are studied; these papers are presented by students and the topic is discussed using associated assignments. 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