



4TU Programme Construction Management & Engineering

STUDY GUIDE ACADEMIC YEAR 2022-2023

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WHY STUDY CME AT 4TU?

By registering as a 4TU-CME student you grant yourself great opportunities.

Firstly, you have the possibility to follow ample courses in the field of Construction Management and Engineering (CME). CME is a broad topic, but together, the three involved universities cover almost every CME topic you can think of.

Secondly, in your graduation project you can have supervisors of different universities, which may have a great impact on the quality of your work.

Thirdly, by cooperating with students of other TU's your view will expand, you will get new insights and learn to solve problems in many different ways.

This study guide provides all the information you need in order to find out what are the topics at the different locations, what are recommended courses, how to enrol for courses at each location and how to get into contact with the right persons. We wish you a fruitful cooperation and exchange!

The 4TU-CME Management Team

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, digitalisation, 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 Delft University of Technology, the master CME is an interfaculty program that is offered by the faculties of Civil Engineering & Geosciences (CEG), Architecture & the Built Environment (ABE) and Technology, Policy & Management (TPM). Through the shared expertise and collaboration of the three faculties, CME in Delft prepares students with relevant prior education in engineering technology for a management career in the construction industry, or for an engineering management research career in academia. This is achieved by combining the already existing engineering expertise of our students with managerial competences and by enhancing their academic and engineering skills in order to maximize the value of the construction industry for society. In addition, the master CME in Delft educates students to design, develop and evaluate innovative management systems and holistic management strategies for the construction industry and to teach students how to lead, steer and serve management processes to effectively perform engineering management for the construction industry. Moreover, at CME in Delft students learn how to collaborate effectively in an interdisciplinary team with diverse talents, skills, characters and cultural backgrounds with the aim to optimize team performance.

Within the master CME at Delft University, large-scale management and engineering challenges are addressed that are related to system and project optimisation, ageing infrastructures, urbanisation and the energy transition as well as the sustainable development and digitalisation of the construction industry. To learn how to face these challenges, Delft CME-students follow one of the following specialisations: Engineering & Systems, Projects & People and Design & Integration.

Recommended courses from other locations:

From UT:

- » Construction Industry Dynamics
- » Sustainable Transportation Infrastructure
- » Circular Systems Engineering

From TU/e:

- » Technology Entrepreneurship
- » Fundamentals of BIM
- » Project redevelopment of problem areas
- » Smart healthy Urban Environment
- » Project Big data for urban analysis

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. At TU/e, the graduation specialization of CME is focused on the management and implementation of information processes. CME graduation projects are often executed in collaboration with industry partners, engineering offices or government institutes, using a combination of urban/building sciences and management and innovation sciences to develop solutions for smart cities and smart buildings. The final graduation project has a clear scientific signature and is grounded in actual smart building and smart cities challenges.

Recommended courses from other locations:

From TUD:

- » Financial Engineering

From UT:

- » Construction Industry Dynamics
- » Sustainable Transportation Infrastructure BIM and 5D Planning

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 focuses on market dynamics, on the organization of the construction industry and the management of the various stages of the design and building process. Another focus is on digital technologies in construction in which both industry dynamics and process management are combined like BIM, 5D planning, and Digital Twins. 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: Circular Systems Engineering, Construction Industry Dynamics, Procurement Strategies and Tendering, Sustainable Transportation Infrastructure, Planning and Process Management and Digital Technologies in Construction.

Recommended courses from other locations:

From TUD:

- » Financial Engineering

From TU/e:

- » Technology Entrepreneurship
- » Fundamentals of BIM
- » Parametric design
- » Research and development project

SHARED SUPERVISION (DURING GRADUATION)

When you are starting your graduation project and one of the experts of your topic is at another TU-location. Just add the lecturer to your graduation committee! This is a great way of improving the level of your graduation. Also, it is a great way to assure the quality of the graduation project.

You will be in the lead of organising this, contacting the supervisor whether he is available and make it work.

ONLINE COURSES AT OTHER LOCATIONS

Below you find an overview of courses that are suitable to attend at another location since they have one or more online components. This list will grow since 4TU is eager to develop more online courses the years to come.

TU Delft

Course Code	Course name	Online components*	Offline components*
AR8003TU	Legal & Governance Aspects	Video Lectures, Assignments	Examination (at own location)
CME2300	Financial Engineering	Video lectures, Collegerama	Examination (at own location)
CME2201	Dynamic Control of Projects	Video lectures, online material, Essay and online assignments	

TU Eindhoven

Course Code	Course name	Online components*	Offline components*
7ZM6M0	Legal & Governance Aspects	Video Lectures Assignments	Examination (at own location)
7ZM5M0	Process modelling and Information management	Web lectures	Assignments and online quizzes

University of Twente

Course Code	Course name	Online components*	Offline components*
201900107	Legal & Governance Aspects	Video Lectures, Assignments	Examination (at own location)

You have an automatic 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 environments 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. If you have difficulties receiving a side registration, please contact: cme@4tu.nl

ATTENDING COURSES AT ANOTHER LOCATION

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 Delft University of Technology with a NetID. With this NetID you have access to Brightspace, in order to register for courses, and Osiris, in order to register for exams.

If you have not received this information, please mail to cme@4tu.nl.

They 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 esa@tue.nl (Mr. B. Viveen). They will then create new login details for you

2. Register yourself for the course in Brightspace (<https://brightspace.tudelft.nl>).
3. Register yourself for the examinations of the course through Osiris via Brightspace.
4. Sign up at the study advisor at the Delft University of Technology, (Studyadvisors-CEG@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 Education and Student Affairs (ESA) of the Eindhoven University of Technology with a student number, email address etc. With this data you have access to Osiris in order to register for courses and exams at the Eindhoven University of Technology.

If you have not received this information, please mail to cme@4tu.nl. They will organise this information through Education and Student Affairs (ESA) for you.

2. Register yourself for the course and examinations through Osiris (<https://osiris.tue.nl>).
3. Sign up at the study advisor at the TU/e, Mrs. J.A.M. Pulles (J.A.M.Pulles@tue.nl) for more specific information about studying in Eindhoven.

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 Osiris in order to register for courses at the University of Twente.

If you have not received this information, please mail to coordinator-ce@utwente.nl. They 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 esa@tue.nl (Mr. B. Viveen). They will then create new login details for you.

Register yourself for the course and examinations through Osiris (osiris.utwente.nl) and your enrolment will automatically be linked to the corresponding Canvas page.

2. See Canvas at <https://canvas.utwente.nl>.
3. Contact the study advisor at the UT Ir. M.J.B. Duyvestijn (m.j.b.duyvestijn@utwente.nl) for more specific information about studying in Twente.

GRADUATION THEMES AT THE THREE LOCATIONS

GRADUATION THEMES IN DELFT

In Delft, the graduation themes are directly related to the three CME specialisations:

1. *Engineering & Systems:*

The specialisation Engineering & Systems focuses on improving system performance in engineering management and real-life problem-solving using system-development and open-design methods. Examples of key graduation topics are:

- » Systems engineering, asset and operations management
- » Information modelling (BIM)
- » Risk and safety analysis and management
- » Supply chain integration, optimisation and reversal

2. *Projects & People:*

The specialisation Projects & People focuses on management of projects using a holistic approach by, for and with people collaborating across organizations and on learning to adapt to change.

Examples of key graduation topics are:

- » Adaptive project management, governance and leadership
- » Managing complex(ity of) projects
- » Collaboration and stakeholder management
- » Procurement and contracting
- » Transition and process management

3. *Design & Integration*

The specialisation Design & Integration aims to design and realize plans that address societal challenges by integrating contextual needs and requirements, and by following design and action research approaches. Examples of key graduation topics are:

- » Integral and transdisciplinary design
- » Urban development and innovation
- » Sustainable and circular business models
- » Financial and entrepreneurial engineering
- » Legal and governance

GRADUATION THEMES IN EINDHOVEN

At TU/e the graduation specialization of CME anticipates changes in how we think about the construction and reconstruction of cities and buildings by exploring the area between 'construction engineering' and 'scientific management and economics'. It focuses on the management and implementation of information processes, emphasizing smart cities and smart buildings. The CME program is grounded in societal challenges such as climate change, energy transition, circular economy, digital twinning, etc. In particular, it looks at:

1. *City Information Management*

Considering the emerging field of urban informatics (including geospatial data, sensor data, 3D city data, etc.), creating virtual representations of cities with real-time connections to the physical world and its inhabitants, cater to various stakeholders, such as municipalities, citizens, architects, urban planners, transport engineers, and construction companies, to make informed decisions using urban analytics in the context of smart cities.

2. *Building Information Management*

Handling and managing building information throughout the building life cycle, improving the Architecture, Engineering, Construction, operation, and demolition process, using both static data (including building models, point clouds) and dynamic data (including sensor data, IoT), allowing for the creation of digital twins of buildings and its occupants, and real-time data processing employing AI technology in the context of smart buildings.

GRADUATION THEMES IN TWENTE

The graduation themes in Twente are related to the two main study profiles:

1. *Markets & Organization in Construction*

The profile Markets & Organisation of Construction familiarises students with the complexity of the market dynamics within the construction industry. It focuses on the analysis, management and organisation of the design, construction and maintenance processes, as well as the coordination of the activities and roles of parties involved. 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.

2. *Digital Technologies in Construction*

Digital Technologies 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. The profile Digital Technologies in Construction helps students to become an expert in managing and enhancing large construction projects using the latest technologies, thereby preparing them for the digital future of the construction industry.

Within these profiles the final graduation theme is selected. Typical themes students work on in Twente include:

- » Asphalt paving innovations
- » Urban resilience
- » Construction ecosystem design
- » Simulation and visualization technologies
- » Infrastructure asset management
- » System engineering and circularity
- » Sustainable and circular construction
- » Procurement of construction projects

The graduation at Twente has a strong design orientation. In close collaboration with industry partners students study wicked real-life problems and propose solutions to these problems.

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.

CAREER OPPORTUNITIES AFTER CME

After the CME master you can choose out of several options, such as directly working in the industry, a paid combination of education and working on a practical design in industry (EngD), 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 such as Rijkswaterstaat, NGO's 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.

ENGD - 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. The EngD programmes were formerly known as the PDEng programmes.

The **practical focused** EngD (Engineering Doctorate) programmes in Civil Engineering (UT) and Smart - Buildings & Cities (TU/e) are open for CME graduates.

During the EngD 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.

An EngD-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. The EngD programme is fulltime and takes two years to complete.

By doing an EngD-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 EngD. **During the two years the programme lasts, the EngD trainees receive a salary.**

For more information you can check the websites of the EngD Civil Engineering and the EngD Smart Buildings & Cities:

- » EngD Civil Engineering: www.utwente.nl/engd
- » EngD Smart Buildings & Cities: www.tue.nl/sbc

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/graduate-school/phds/>
- » University of Twente: www.utwente.nl/tgs

ORGANISATION OF THE 4TU CME MASTER PROGRAMME

COORDINATORS AT THE THREE LOCATIONS

COORDINATORS IN DELFT

Ir. J.S. (Jeroen) Hoving, Director of Studies CME

- » Room: Building 23, 6.69
- » Phone: +31 15 27 85723
- » E-mail: j.s.hoving@tudelft.nl

Dr.ir. G.A. (Sander) van Nederveen, coordinator Engineering & Systems

- » Room: Building 23, 6.64
- » Phone: +31 15 27 81854
- » E-mail: g.a.vannederveen@tudelft.nl

Dr.ir. M.G.C. (Marian) Bosch-Rekvelde, coordinator Projects & People

- » Room: Building 23, 6.69
- » Phone: +31 15 27 84771
- » E-mail: m.g.c.bosch-rekvelde@tudelft.nl

Dr. D.F.J. (Daan) Schraven, coordinator Design & Integration

- » Room: Building 23, 6.69
- » Phone: +31 15 27 85967
- » E-mail: d.f.j.schraven@tudelft.nl

COORDINATOR IN EINDHOVEN

Dr. Q. (Qi) Han

- » Room: VRT 9.11
- » Phone: 040 247 5403
- » E-mail: q.han@tue.nl

COORDINATOR IN TWENTE

Dr.. A. (Andreas) Hartmann

- » Room: Horst Z229
- » Phone: 053 489 2084
- » E-mail: a.hartmann@utwente.nl

STUDY ADVISORS AT THE THREE LOCATIONS

STUDY ADVISORS IN DELFT

Jorieke van Harten Marian Roodenburg
Pascal de Smidt Anneloes Klapwijk

- » Room: Building 23, rooms 2.77, 2.77.1 and 2.79
- » E-mail: studyadvisors-CEG@tudelft.nl
- » Online: [For appointments](#)

STUDY ADVISOR IN EINDHOVEN

Mrs. J.A.M. (Josée) Pulles

- » Room: VRT 2.12
- » Phone: 040-247 8725 (if no answer: 040-247 3990)
- » E-mail: mailto:j.a.m.pulles@tue.nl

STUDY ADVISOR IN TWENTE

Ir. M.J.B. (Monique) Duyvestijn

- » Room: Horst BH-113
- » Phone: 053-489 3456
- » E-mail: m.j.b.duyvestijn@utwente.nl
- » Online: Appointments via <https://et.planner.utwente.nl/>

TRACK COORDINATOR CME AT UT

Drs. Ing. J. (Hans) Boes

- » Room: Horst Z214
- » Phone: 053-4894881
- » E-mail: j.boes@utwente.nl

EXAMINATION COMMITTEES AT THE THREE LOCATIONS

BOARD OF EXAMINERS IN DELFT

Members of the Board of Examiners CEG in Delft:

- » Chair: Dr.ir. G.G. Drijkoningen
- » Vice-chair: Dr. E. Mostert
- » Member: Dr.ir. A. Straub (CME)
- » Member: Dr.ir. G.A. van Nederveen (CME)
- » Member: Dr. P.G. Ditmar
- » Member: Dr.ir. D.J.M. Ngan-Tillard
- » Member: Dr. V.L. Markine
- » Member: Dr.ir. D.A. Koleva
- » Member: Dr. R.M.P. Goverde
- » Member: Dr.ir. O. Morales Napoles
- » Member: Dr.ir. M. Kroesen
- » Member: Dr.ir. X. Jiang
- » External Member: Dr.ir. E. van Kampen
- » Secretary: B. Zaaijer, LL.M.

EXAMINATION COMMITTEE IN EINDHOVEN

Members of the Examination Committee in Eindhoven:

- » Chair: Prof.dr. B.J.F. Colenbrander
- » Vice-chair: Dr. Q. Han (CME)
- » Member: Dr. T. Feng
- » Member: Dr. ir. G.I. Curulli
- » Member: Dr. ir. M.G.L.C. Loomans
- » Member: Ir. B.W.E.M. van Hove
- » External member (Dep. Industrial Design): Prof. dr. ir. J.B.O.S. Martens
- » Academic advisor: Mrs. J.A.M. Pulles (CME/GS)
- » Academic advisor: Mrs. J.H. Steetskamp (BC)
- » Academic advisor: L. Kamphorst Msc (BC)
- » Secretary: Ms. M.M. Theunissen

EXAMINATION COMMITTEE IN TWENTE

Members of the Examination Committee in Twente:

- » Chair: Prof.dr.ing. K.T. Geurs (chairman)
- » Member: Dr.ir. B.W. Borsje
- » Member: Dr.ir. L.L. olde Schotenhuis
- » Member: Dr. M.S. Krol
- » External member: Ir. J.P. Boutkan (Province of Overijssel)
- » Registry: Drs. E. Ruijgh
- » Secretary: Dr. K. Vink

EDUCATION COMMITTEES AT THE THREE LOCATIONS

BOARD OF STUDIES CME IN DELFT

Members of the Board of Studies CME in Delft:

- » Chairman: Dr.mr. F.A.M. Hobma
- » Staff member: Dr. E.J. Houwing
- » Staff member: Dr. M. Leijten
- » Student member: Ms. J. Gerlag
- » Student member: Ms. W.P.A. van der Meer
- » Student member: Ms. A.E. Chalazia
- » Secretary: Ms. E. van der Kruk

EDUCATION COMMITTEE IN EINDHOVEN

Members of the Education Committee in Eindhoven:

- » Chairman: Dr.ir. S.P.G. Moonen (SED)
- » Staff member: Dr. Q. Yu (BPS)
- » Staff member: Dr. I.V. Ossokina (USRE)
- » Staff member: Dr. D. Yang (CME)
- » Vice-chair: Ing. J.P.F.A. Snijders (AUDE)
- » Student member: Ms. I. Klasen (CME/Of CoUrsE!)
- » Student member: Ms. C. Aalders (Cheops)
- » Student member: Ms. S. Driessen (SED/KOers)
- » Student member: Ms. L. Cauneac (AUDE/AnArchi)
- » Student member: Ms. Q. Heijnen (USRE)
- » Secretary: Mrs F.M. Clijsters (VRT 2.08) f.m.clijsters@tue.nl - 040-2472711

EDUCATION COMMITTEE IN TWENTE

Members of the Education Committee in Twente:

- » Chairman: Dr.ir. M.J. Booij
- » Staff member: Dr. V. Magnanimo
- » Staff member: Dr.ir. M.B. Ulak
- » Staff member: Dr.ir. F. Vahdatikhaki
- » Staff member: Dr.ir. E.M. Horstman

- » Student member: T. Achterkamp
- » Student member: A. Chechin
- » Student member: F.L.D. Witjes
- » Student member: V.G.E. Glas
- » Quality Assurance: I. Mulder

- » Advisor: P.Jansen, MSc
Dr.ir. D.C.M. Augustijn
L. Raadschelders

- » Secretary: Drs. E. Ruijgh

STUDY ASSOCIATIONS AT THE THREE LOCATIONS

STUDY ASSOCIATION IN DELFT

CME Dispuut
Building 23, Room 6.70
Postbus 5048
2600 GA Delft

Location

Address: Stevinweg 1, Building 23, Room 6.70
Phone: +31 15 27 85012
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

Address: Vertigo floor 2, De Zaale
Phone: 040 247 5025
E-mail: info@ofcoursecme.nl
Website: www.ofcoursecme.nl

STUDY ASSOCIATION IN TWENTE

Study Association ConcepT
Horst (basement) C-016
Postbus 217
7500AE Enschede

Location

Address: Horst building (basement) C-016, 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 6.70
Postbus 5048
2600 GA Delft

Location

Address: Stevinweg 1, Building 23, Room 6.70
Phone: +31 15 27 85012
E-mail: info@cmedispuut.nl
Website: www.cmedispuut.nl
LinkedIn: www.linkedin.com/groups/CME-Alumni-3663314

ALUMNI ASSOCIATION IN EINDHOVEN

Association for Construction Managers and Engineers (ACME)
Vertigo Vloer 9
Postbus 513
5600 MB Eindhoven

Location

Address: Vertigo Vloer 9
Phone: 040 247 2373
Email: acmeeindhoven@gmail.com
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

Location

Address: p/a Alumni bureau Universiteit Twente
Phone: 00
Email: concreet@concept.utwente.nl
Website: <https://www.concept.utwente.nl/concreet/home>
LinkedIn: www.linkedin.com/groups/55115

COMPULSORY COURSES AT THE THREE CME LOCATIONS

The study programme is composed as follows:

	item	TUD	TU/e	UT
		EC	EC	EC
1	Core programme (compulsory courses)	42-46	30	30
2	Specialisation courses (depending on specialisation)	17-26	35	
3	Electives (depending on specialisation)	15-26	15	
4	Graduation work	35	40	

CORE CURRICULUM: COMPULSORY COURSES IN DELFT (42 TO 46 EC)

Course Code	Name	Period	Responsible lecturer	EC
AR8003TU	Legal and Governance	1	Dr.mr. F.A.M. Hobma	5
CME2300	Financial Engineering	1	Dr. D.F.J. Schraven	4
CME4150	Managing Uncertainty and Data	1	Dr.ir. M. Nogal Macho	4
CME4200	Intercultural Relations	1	Dr.ir. C. van Daalen	2
CME1201	Collaborative Design and Engineering	2	Dr. E.J. Houwing	5
CME4000	Project Management	2	Dr. M. Leijten	6
CME4300	Engineering Asset Management	2	Prof.dr.ir. A.R.M. Wolfert	5
CME4120	Information Systems for the Construction Industry	3	Dr.ir. G.A. van Nederveen	4
R&D Course: (choose at least one out of:)				
CME5020	Research and Development Methods for P&P and D&I	4	Dr. J. Ninan	3
CME5030	Research and Development Methods for E&S	4	Prof.dr.ir. A.R.M. Wolfert	5
Ethics Course: (choose at least one out of:)				
WM0329TU	Ethics and Engineering	1 or 3	Dr. F. Santoni De Sio	6
WM0376TU	Ethics of Technological Risk	3	Prof.dr. S. Roeser	5
WM0312CIE	Philosophy, Technology, Assessment and Ethics	4	Dr. S.M. Copeland	4
TPM003A	Water Ethics	2	Prof.dr.mr.ir. N. Doorn	5

COMPULSORY COURSES IN EINDHOVEN (30 EC)

Course Code	Name	Period	Responsible lecturer	EC
1CM900	Project Management	2	S.U.K. Rohmer	2.5
1ZM65	System Dynamics	3	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
7ZZ9M0	Design Science Methodology and Systems Engineering	1	Prof.dr.ir. B. de Vries	5
7ZZ6M0	Legal & Governance Aspects	1	Prof.dr.ir. B. de Vries	5

COMPULSORY COURSES IN TWENTE (30 EC)

a. Profile courses Markets & Organization of Construction

Course Code	Name	Period	Responsible lecturer	EC
201800040	Research Methodology and Academic Skills	2	Dr. A. Hartmann	5
Profile courses (minimum 30 EC including compulsory courses)				
201900107	Legal & Governance Aspects	1	Dr. P.J. Klok	5
201800072	Planning and Process management	1	Dr. M. van Buiten	5
202200057	Sustainable Transportation Infrastructure	1	Dr. J.M. Oliveira dos Santos	5
201800047	Construction Industry Dynamics	2	Prof.dr.ir. A.G. Doree	5
201800029	Construction Process Management	2	Prof.dr.ir. L. Volker	5
202200043	Circular Systems Engineering	3	Dr.ir. M.C. van den Berg	5
201800034	Infrastructure Asset Management	4	Dr. A. Hartmann	5

b. Profile courses Digital Technologies in Construction

Course Code	Name	Period	Responsible lecturer	EC
201800040	Research Methodology and Academic Skills	2	Dr. A. Hartmann	5
Profile courses (minimum 30 EC including compulsory courses)				
201900107	Legal & Governance Aspects	1	Dr. P.J. Klok	5
201800072	Planning and Process management	1	Dr. M. van Buiten	5
201800047	Construction Industry Dynamics	2	Prof.dr.ir. A.G. Doree	5
201800029	Construction Process Management	2	Prof.dr.ir. L. Volker	5
201800032	Circular Systems Engineering	3	Pr.ir. M.C. van den Berg	5
201800044	Digital Technologies in Construction	3	Dr. X. Yin	5
201800052	Technology and Innovation in Road Construction	4	Dr. S.R. Miller	5

OVERVIEW OF THE COURSES IN DELFT

CORE CURRICULUM: COMPULSORY COURSES IN DELFT

CORE CURRICULUM: COMPULSORY COURSES IN DELFT (42 TO 46 EC)

Course Code	Name	Period	Responsible lecturer	EC
AR8003TU	Legal and Governance	1	Dr.mr. F.A.M. Hobma	5
CME2300	Financial Engineering	1	Dr. D.F.J. Schraven	4
CME4150	Managing Uncertainty and Data	1	Dr.ir. M. Nogal Macho	4
CME4200	Intercultural Relations	1	Dr.ir. C. van Daalen	2
CME1201	Collaborative Design and Engineering	2	Dr. E.J. Houwing	5
CME4000	Project Management	2	Dr. M. Leijten	6
CME4300	Engineering Asset Management	2	Prof.dr.ir. A.R.M. Wolfert	5
CME4120	Information Systems for the Construction Industry	3	Dr.ir. G.A. van Nederveen	4
R&D Course: (choose at least one out of:)				
CME5020	Research and Development Methods for P&P and D&I	4	Dr. J. Ninan	3
CME5030	Research and Development Methods for E&S	4	Prof.dr.ir. A.R.M. Wolfert	5
Ethics Course: (choose at least one out of:)				
WM0329TU	Ethics and Engineering	1 or 3	Dr. F. Santoni De Sio	6
WM0376TU	Ethics of Technological Risk	3	Prof.dr. S. Roeser	5
WM0312CIE	Philosophy, Technology, Assessment and Ethics	4	Dr. S.M. Copeland	4
TPM003A	Water Ethics	2	Prof.dr.mr.ir. N. Doorn	5

SPECIALISATION COURSES IN DELFT

a. Specialisation: Engineering & Systems

Course Code	Name	Period	Responsible lecturer	EC
CME4481	Systems Engineering Design	3	Prof.dr.ir. A.R.M. Wolfert	5
CME4170	Construction Technology	1	J.P.G. Ramler	5
CME4701	Construction Management Systems	2	Dr.ir. R. Binnekamp	4
Must choose at least one, but may also choose multiple				
CME4500	Engineering Systems Optimisation	4	Prof.dr.ir. A.R.M. Wolfert	4
TPM024a	Methods for Risk Analysis and Management	4	Prof.dr. G.L.L.M.E. Reniers	5
EPA1352	Advanced Simulation	3	Dr. Y. Huang	5
EPA1316	Introduction to Data Science	1	Dr. T. Verma	5

b. Specialisation: Projects & People

Course Code	Name	Period	Responsible lecturer	EC
CME4100	Process Management	3	Dr. M. Leijten	5
CME2201	Dynamic Control of Projects	4	Dr.ir. M.G.C. Bosch-Rekvelde	4
CME4600	Leadership & Strategic Management	4	Prof.dr. P.W.C. Chan	4
Must choose at least one, but may also choose multiple				
CME4800	Procurement of Complex Public Projects	3	Dr.ir. A. Straub	5
CIE5981	Forms of Collaboration in Civil Engineering	1	Prof.dr.ir M.J.C.M. Hertogh	4
TPM024a	Methods for Risk Analysis and Management	4	Prof.dr. G.L.L.M.E. Reniers	5

c. Specialisation: Design & Integration

Course Code	Name	Period	Responsible lecturer	EC
CME4100	Process Management	3	Dr. M. Leijten	5
AR2MBE025	Urban and Infrastructure (Re)development Game	4	Dr. A. Ersoy	10
CME4400	Entrepreneurial Engineering	4	Dr. D.F.J. Schraven	5
TPM023A	Cost-Benefit-Analysis: Theory and Application	1	Dr.ir. Z. Roosenboom-Kwee	4
AR0179	Value Capturing	2	Ir. H.W. de Wolff	5

General electives

Course Code	Name	Period	Responsible lecturer	EC
WM0201TU	Technical Writing	1,2,3,4	Drs. M. Blikendaal	2
Choose at most one out of:				
CME2100-11	Research Internship	1,2,3,4	Dr.ir. M.G.C. Bosch-Rekvelde	10
CME4900	Open Design Contractor Project	1,2,3,4	Prof.dr.ir. A.R.M. Wolfert	10
TUD4040-10EC	Joint Interdisciplinary Project	1	Prof.dr.ir. J. Hellendoorn	10
CME4950	Research and Development Project	1,2,3,4,	Ir. J.S. Hoving	10

Graduation Thesis

Course Code	Name	Period	Responsible lecturer	EC
CME5100	CME Master Thesis Preparation	1,2,3,4	Ir. J.S. Hoving	5
CME5200	CME Master Thesis	1,2,3,4	Ir. J.S. Hoving	30

COURSE DESCRIPTIONS IN DELFT

Legal and Governance	
<i>Responsible lecturer</i>	Dr.mr. F.A.M. Hobma
<i>Course code</i>	AR8003TU
<i>Period</i>	1
<i>ECTS</i>	5
Course description:	
<p>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.</p> <p>Legal aspects mainly rest in limitations and possibilities created by the legal system, as a context for interactions within and across the public and the private sector boundaries, during the complete life-cycle of the construction process. The relevant legal and institutional frameworks and their underpinnings will be explained and analysed and put into the perspective of 'real-life' problems. Insight into legal reasoning, as a specific methodology, will be practised through the use of legal literature and jurisprudence.</p> <p>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.</p>	

Financial Engineering	
<i>Responsible lecturer</i>	Dr. D.F.J. Schraven
<i>Course code</i>	CME2300
<i>Period</i>	1
<i>ECTS</i>	4
Course description:	
<p>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:</p> <ul style="list-style-type: none"> • 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 including characteristics of typical projects like oil wells, open mining, infrastructure and office buildings. • Future trend topics for finance, especially implications of sustainability and circularity 	

Intercultural Relations

Responsible lecturer	
Course code	
Period	
ECTS	

Course description:

This course introduces students to some theories on diversity and dimensions of national cultures as defined by Hofstede and others. Through role-playing games and exercises the students engage with the theory and reflect on their own intercultural experience and develop their cross-cultural sensitivity.

Departing from sociological and psychological theories on communication in-group/out-group this course will treat themes like diversity, inclusiveness and intercultural cooperation. It takes a dynamic and multifaceted approach to culture as its starting point. The intention is to organize two serious games/training sessions for which participation is highly recommended. Self-study is required. A TOPOI analysis and writing assignment will be used as a test at the end of the course.

Engineering Asset Management

Responsible lecturer	Prof.dr.ir. A.R.M. Wolfert
Course code	CME4300
Period	1
ECTS	5

Course description:

Engineering Asset Management (EAM) is a holistic approach to manage portfolios of assets, overarching the worlds of project management, construction management and operations management.

The alternative view within this course is to provide an integrative viewpoint, where EAM is:

1. is a purpose-economic model in which finance-, gaia- and socio-logical values are integrated both for the user and service provider,
2. a dynamic balancing act between commercial demands, technical supply and financial resources to optimally provide quality of service, and
3. a dynamic service provisioning approach capable of cyclic service provisioning and open loops management.

In this course the following concepts are addressed:

1. The QoS concept (strategic planning & integration: systems thinking -zooming ; its role in the service provider organisation; relation EAM with different levels of DBMO in relation with PM and CM);
2. QoS from User demand and from Asset supply perspective (dynamic service needs, and dynamic technology enablers);
3. Financing (OPEX, CAPEX, cash flow, NPxV, financial feasibility, capital planning and budget, LCC, EAC);
4. Environmental constraints (regulator, governmental, societal, ecological);
5. Managing your in service assets (knowing your assets, service logistics, contracting and outsourcing DBMO);
6. Engineering your in-service assets (engineer for Y's: the measures of performances; e=mscsquair);
7. Safeguarding your in-service assets (integral safety and security)

This course has a constructivist character, in which the student is guided and encouraged to develop open design knowledge & solutions ('openings') using the self-chosen Service Provider of Interest (SPoI) as a connective vehicle enabling the Open Design Learning (ODL) response. The SPoI can be managing transportation, water management, communication and/or energy infrastructure.

Collaborative Design and Engineering

Responsible lecturer	Dr. E.J. Houwing
Course code	CME1201
Period	2
ECTS	5

Course description:

In this course, students learn how to collaborate in large multidisciplinary teams on an ill-defined engineering assignment. Each group has to deal with an overload of information that needs to be structured in the design process, in order to identify the underlying engineering problem and present a solution to a client in an effective and efficient way. During the course, students are taught how to identify bad team performance and its effect on the design process, and how to intervene.

Students are introduced to the field of Group Dynamics in a series of three workshops (Partnering Charter; Belbin-test; giving and receiving feedback) in the first half of the course. The outcomes of the workshops help students to organize the creation of joint deliverables: Partnering Charter, Project Management Plan, Phase I-report (analysis) and Phase II-report (design-solutions). Overall, students are exposed to an experience of intensive groupwork. Grading is based both on group and individual performance.

Project Management

Responsible lecturer	Dr. M. Leijten
Course code	CME4000
Period	2
ECTS	6

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 presents the foundations of project management, as well as more advanced academic analyses on the matter and has been developed primarily to understand the role of project management in construction. It provides an introduction to the methods and tools of project management and how they function in the process of constructing an asset. The course provides students with the knowledge necessary to understand how projects can be managed.

The curriculum follows the competencies required to move a project through its various stages. 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 relationships between project stakeholders.
- » Risk analysis and management

Responsible lecturer	Dr.ir. R.C. Lanzafame
Course code	CIE4130
Period	2
ECTS	4

Course description:

This course focuses on the characterization and assessment of safety for civil engineering structures using probabilistic methods. As such, the course contents include:

- Probability calculus: probability theory, random variables (discrete and continuous), functions of random variables, parametric distributions, Maximum Likelihood estimation, extreme value theory, multivariate probability distributions, dependence
- Risk analysis and evaluation: decision-making under uncertainty, individual and societal risk, economic optimization, safety standards
- Reliability analysis: Level I, II and III methods for evaluating reliability, time dependence, reliability of systems
- Design applications: design codes in civil engineering, target reliability levels, characterization of loads, strengths and effects

Information Systems for the Construction Industry

Responsible lecturer	Dr.ir. G.A. van Nederveen
Course code	CIE4120
Period	3
ECTS	4

Course description:

Information Systems for construction Management (ISM) are part of the asset and construction management processes supported by various tools, technologies involving the generation and management of digital representations of engineering assets.

The alternative view within this course is to not only represent physical, and functional characteristics of the engineering asset (3D) but also represent so-called 'design for ty' information characteristics for the entire asset service life.

In this course the following concepts are addressed:

1. Building information modelling and design for ty's;
2. Geometric 3D computer modelling;
3. Constructability within information systems;
4. Maintainability within information systems;
5. Safety within information systems;
6. Sustainability within information systems;
7. ISM future outlook.

This course has a constructivist character, in which the student is guided and encouraged to develop open design knowledge & solutions ('openings') using the self-chosen Project of Interest (PoI) as a connective vehicle enabling the Open Design Learning (ODL) response. The PoI is either being constructed or already been constructed (must have passed the initial phase)

Methodology for Scientific Research	
Responsible lecturer	Prof.dr.ir. H.E.J.G. Schlangen
Course code	CIE4030
Period	4
ECTS	3
Course description:	
<p>This course is intended for students that would like to 'Design a Research Project'. It is a perfect preparation for your final project in your MSc.</p> <p>The topics that will be presented in this course are:</p> <ul style="list-style-type: none"> • 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 • Reporting and presenting your research <p>The course is given using Online-lectures. The assessment of the course will be done via two assignments.</p>	

Ethics of Technological Risk	
Responsible lecturer	Prof.dr. S. Roeser
Course code	WM0376TU
Period	1
ECTS	5
Course description:	
<p>This course investigates ethical aspects of technological risks. Debates about technological risks related to, for example, energy technologies, robotics and biotechnology frequently culminate in stalemates. This is due to the complexities and intricacies inherent to such debates as they involve scientific information and uncertainties, as well as ethical and emotional considerations.</p> <p>Conventional, quantitative approaches focus primarily on statistical information to risk. They do not explicitly incorporate important ethical considerations such as justice, fairness and autonomy. Emotions such as compassion, care and feelings of responsibility can draw attention to such ethical aspects of risky technologies. Taking emotions and ethical considerations seriously can lead to more fruitful deliberations between different stakeholders in which relevant concerns are taken seriously and are explicitly reflected upon. This course will study how approaches to ethical aspects of risk can lead to more morally responsible decision making and design of technological innovations.</p>	

Philosophy, Technology, Assessment and Ethics	
Responsible lecturer	Dr. S. M. Copeland
Course code	WM0312CIE
Period	4
ECTS	4
Course description:	
This module explores philosophical and ethical questions in civil engineering, as well as providing a basic introduction into Technology Assessment.	

Water Ethics	
Responsible lecturer	Prof. Dr. Mr.ir. N. Doorn
Course code	TPM003A
Period	4
ECTS	5
Course description:	
Water is essential for life. While we can in principle survive weeks without food, without water, we would not survive more than a couple of days.	
The aim of this course is to provide an introduction to philosophical water ethics. It will present the main philosophical issues in the water domain in a practical way by situating these issues within real cases. Questions addressed will include:	
<ul style="list-style-type: none"> » Is it fair to drink water, knowing that the production of one cup of coffee requires 140 litres of water on average? » Should we prioritize between different water uses, like agriculture, navigation, and recreation? » Should we continue building hard flood defences at the expense of the environment? » Should local citizens be given a voice in water-related decision making? 	
These and other questions will be linked to ongoing discussions in the relevant other disciplines within philosophy, most notably in ethics of technology, philosophy and ethics of risks, environmental ethics, climate ethics, and global justice.	
This course will provide students with an understanding of approaches in water engineering and water policy. Students will get experience with discussing and evaluating ethical considerations in water engineering and water policy. Topics covered include: water and justice, water and economic valuation, water and human rights, water and responsibility, and water and engineering.	

Climate Change: Science and Ethics	
Responsible lecturer	Dr. M. Vizcaino
Course code	CIE4510
Period	2
ECTS	4
Course description:	
<p>Climate change is one of the most profound and complex issues affecting our society and economy today. Many scientists argue that there are too many variable factors to effectively see the big picture, while other scientists who believe human activity is to blame for global warming are ready to outline specific actions to prevent more damage. Skeptics believe that climate change is part of the natural global progression and that human activity will neither worsen nor improve our situation.</p> <p>Those who are in favor of a global effort to reverse climate change believe that current climate models are an useful tool to estimate future warming and argue that the uncertainty surrounding this threat is no excuse for inaction. Skeptics in turn argue that scientists who want to attract attention to themselves, who want to attract great funding to themselves, have found a way to scare the public by making things bigger and more dangerous than they really are. Despite continuing uncertainties about the detailed linkages, extreme weather events are increasingly being attributed to human interference, and greater emphasis is emerging on the need to prevent and to adapt to climatic changes.</p> <p>The course provides an introduction to the basic physics of the climate system, how climate has changed in the past and how climate will change in the future. The focus is on the energy balance of the climate system and how this balance is affected by greenhouse gases and aerosols; the physical processes in the atmosphere and oceans that shape the climate; the response of the oceans, ice sheets and glaciers to global warming; the evidence for past and present climate change; climate models and model uncertainties; climate predictions.</p> <p>A second focal point of the course is the broader societal and ethical aspects of climate change. In particular, we will focus on past emissions and responsibilities, implications of global warming on human safety and security, the distribution of burdens and benefits, emission rights, international justice and intergenerational justice.</p>	
Syllabus:	
<ul style="list-style-type: none"> » Introduction to climate physics » Records of past Earth's climate » Radiative heat transfer » Atmospheric circulation » Clouds, aerosols, and climate » The carbon cycle » Forcings and feedbacks in the climate system » Climate change and sea level rise » Ice in the Climate System » Climate modeling and predictions 	

Course descriptions of the specialisation electives can be found at [Study Guide](#).

GRADUATION IN DELFT

Master Thesis, Preparation	
Responsible lecturer	Ir. J.S. Hoving
Course code	CME5100
Period	1, 2, 3, 4
ECTS	4

Course description:

The students will prepare their Master thesis by executing the following steps:

1. Formulate a rough research, development or design proposal in the field of your Construction Management and Engineering specialisation* (max. 1 A4). This proposal may be based on a) the ideas of an involved company, b) university research, or c) personal ideas.
2. Submit your rough proposal to one of the graduation coordinators (preferably the coordinator that best fits the topic) and get approval to continue the thesis preparation.
3. Find a main thesis supervisor in consultation with the graduation coordinator.
4. Establish a thesis committee in consultation with the main thesis supervisor and, if desired and not already involved, find a company/organization to execute the Master thesis with.
5. If you choose to graduate at a company, arrange a graduation agreement in which all conditions for the graduation are stipulated and agreed upon by the company, the student and TU Delft. Note that the rough proposal from step 1 must be included in the graduation agreement. The standard TU Delft graduation agreement, the corresponding procedure and its conditions are available on the Faculty CEG student portal.
6. Finalize the full research, development or design proposal, including a) introduction of the thesis topic, b) problem description and definition, c) thesis objective, d) methodology and e) planning of the Master thesis project.

The course is concluded by approval of the thesis proposal during the Master thesis kick-off meeting. Note here that without a graduation agreement signed by all parties involved, approval of the kick-off proposal may not be given.

**) The thesis topic must be chosen within the scope of your CME specialisation, which is either Design & Integration (D&I), Engineering & Systems (E&S) or Projects & People (P&P). Each specialisation may have specific requirements regarding the thesis topic: please check the CME Brightspace community for the corresponding information.*

Master Thesis	
Responsible lecturer	Ir. J.S. Hoving
Course code	CME5200
Period	1, 2, 3, 4
ECTS	32
Course description:	
<p>The CME Master Thesis consists of individually conducting a research, development or design project in the field of your Construction Management and Engineering specialisation*. The thesis project is based on the thesis proposal approved by your thesis committee as part of CME5100 Master Thesis preparation.</p> <p>During the CME Master Thesis, you are to demonstrate the capacity to conduct your research, development or design project at the academic Master level by showing the ability to be able to independently plan, execute and manage your thesis project. During the thesis project you are additionally expected to demonstrate the ability to apply relevant theory, to set-up and execute a sound methodology, to critically interpret and reflect on obtained results and to present your findings in a well-structured manner through written and oral communications in proper English.</p> <p>As the CME Master Thesis is worth 30 credits, you are expected to finalise the thesis project in approximately 6 months. This excludes the time spent on CME5100 Master Thesis preparation.</p> <p>*) The thesis topic must be chosen within the scope of your CME specialisation, which is either Design & Integration (D&I), Engineering & Systems (E&S) or Projects & People (P&P). Each specialisation may have specific requirements regarding the thesis topic: please check the CME community Brightspace for the corresponding information.</p>	

OVERVIEW OF THE COURSES IN EINDHOVEN

COMPULSORY COURSES IN EINDHOVEN

PROGRAMME OVERVIEW

Core courses (30 EC)	Period	EC
Project Management	2	2.5
System Dynamics	3	5
Process Modelling and Information Management	4	5
Case Study Process Modelling	1	2.5
Collaborative Design	3	5
Design Science Methodology and Systems Engineering	1	5
Legal and Governance Aspects	1	5
Specialisation electives (35 EC out of 75 EC)		
Urban Research Methods	3	5
Smart healthy Urban Environments	2	5
Fundamentals of BIM	2	5
Technology Entrepreneurship	2	5
Entrepreneurial Marketing	2	5
Built Environment and Smart Mobility	4	5
Research and Development Project	1,2,3,4	10
Big data for urban analysis	3,4	10
Urban Planning II	1	5
Parametric Design	3	5
Inner-city modular high-rise	1	5
Smart building Methodology and Technology	3	5
Circularity in the Built Environment	1	5
Free Electives course (15 ECTS)		
All 4TU-CME MSc-courses offered by TU/e, TUD, UT		15
Graduation CME incl. Research proposal (40 ECTS)	1,2,3,4	40

COURSE DESCRIPTIONS IN EINDHOVEN

Internship USRE/CME Relevant Work Experience	
Responsible lecturer	Ir. A.W.J. Borgers
Course code	7ZRWE0
Period	1, 2, 3, 4
ECTS	5
Course description:	
The internship Relevant Work Experience can be one of the electives in the student's personal study plan. It allows the student to acquire some experience in one of the fields related to the built environment.	

Internship USRE/CME Academic Work Experience			
Responsible lecturer	Ir. A.W.J. Borgers		
Course code	7ZAWEO		
Period	1, 2, 3, 4		
ECTS	15		
Course description:			
To be specified in the Internship Plan. The learning objectives must be described on MSc-level and must lead to an academic attitude.			
The learning objectives must:			
<ul style="list-style-type: none"> » be relevant for the development as a starting professional in the field of the Built Environment. » fit into the personal study plan of the student. 			
To establish the contents a choice must be made for:			
<ul style="list-style-type: none"> » a type of internship and » a connection with the unit's research program and/or » a connection with one of the university's strategic areas and/or » a connection with one of the themes of the department. 			
See the scheme below:			
Possible characteristics of the Internship			
Type of internship	Design	Research	Combination
Research Program (Unit)	Design and Decision Support Systems		
Strategic Area (TU/e)	Energy	Smart Mobility	Health
Theme (Department BE)	Quality of Life	Smart Living Environments	Sustainable Transformation

Case Study Process Modelling

Responsible lecturer	Dr. Q. Han
Course code	7ZM3M0
Period	1
ECTS	2.5

Course description:

After the project, the student is able to:

- » Select relevant information for the case study
- » Identify the involved stakeholders' interests
- » Specify the process phases
- » Apply appropriate qualitative methods for analysis:
 - » e.g., Isikawa diagram, stakeholder power/interest grid, SWOT, creating action plan, etc.
- » Identify strengths and weaknesses of the process
- » Provide recommendations for process improvement
- » Write an academic report

Content

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. The information related to the project is introduced by the involved company, students are required to use appropriate methods for analysis. Next, students are required to search all the necessary information online with similar projects using relevant selection criteria and use appropriate methods for comparison analysis and draw conclusions.

The case study focuses more on the soft side of the process in terms of understanding the nature of the interaction between involved stakeholders and decision making on projects within an uncertain and dynamic social, political and physical environment.

This course will be assessed by means of two group assignments (80%) and two pitches (20%).

Project Management

Responsible lecturer	S.U.K. Rohmer
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 to 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	
<i>Responsible lecturer</i>	Dr.ir. B. Walrave
<i>Course code</i>	1ZM65
<i>Period</i>	3
<i>ECTS</i>	5
Course description:	
<p>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 diagrams. 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.</p> <p>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.</p>	

Process Modelling & Information Management	
<i>Responsible lecturer</i>	Dr. Q. Han
<i>Course code</i>	7ZM5M0
<i>Period</i>	4
<i>ECTS</i>	5
Course description:	
<p>This course is about analyzing problems, optimizing processes and managing information flows in the context of urban development projects from city-scale to building level.</p> <p>This course consists of three interlinked modules, which sequentially cover the three key topics (Geo-process models for location selection, decision making under uncertainty and optimization models, information management tools in the building process.). All three modules are linked to a hypothetical new development in a specific city. You can select a development type and a city in the Netherlands of your liking. The development types include a residential building (e.g. apartment complex), a retail centre (e.g. mall), a hotel building or an office building.</p>	
Content	
<p>After the project, the student will be able to:</p> <ul style="list-style-type: none"> • have a multi-scale understanding of the built environment from city to building level regarding the development project. • construct the geo-process model to do spatial analysis (e.g., the site selection) for the development project. • analyse decisions making under uncertainties and develop optimization models under constraints. • apply information management tools in the building process. 	
<p>This course will be assessed by means of three individual assignments (90%) and quizzes (10%)</p>	

Design Science Methodology and Systems Engineering	
Responsible lecturer	Prof.dr.ir. B. de Vries
Course code	7ZZ9M0
Period	1
ECTS	5
Course description:	
Introduction of Design Science Methodology and Systems Engineering theory and principles in the context of the construction sector. Design Science Methodology (DSM), Systems Engineering (SE) and Building Information Modelling (BIM) tools are practiced in individual assignments and the theory is tested in an exam.	

Legal & Governance Aspects	
Responsible lecturer	Prof.dr.ir. B. de Vries
Course code	7ZZ6M0
Period	1
ECTS	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.	
Legal aspects mainly rest in limitations and possibilities created by the legal system, as a context for interactions within and across the public and the private sector boundaries, during the complete life-cycle of the construction process. The relevant legal and institutional frameworks and their underpinnings will be explained and analysed and put into the perspective of 'real-life' problems. Insight into legal reasoning, as a specific methodology, will be practised through the use of legal literature and jurisprudence.	
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.	
This course will be assessed by means of a written exam (75%) and assignments (25%).	

Collaborative Design	
Responsible lecturer	Prof.dr.ir. B. de Vries
Course code	7ZM8M0
Period	3
ECTS	5
Course description:	
<p>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).</p> <p>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.</p> <p>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, and an individual scientific paper as a contribution to the Collaborative Design research and development</p>	

SPECIALISATION ELECTIVES IN EINDHOVEN

Urban Research Methods	
Responsible lecturer	Prof.dr. T.A. Arentze
Course code	7ZW7M0
Period	3
ECTS	5
Course description:	
<p>In this course students learn core research and evaluation methods for urban planning/management. The focus is on quantitative methods and evaluation techniques.</p> <p>The following topics are covered:</p> <ul style="list-style-type: none"> » Decision processes in urban planning and management » Developing a conceptual model for a research problem » Data analysis and modeling techniques » Regression analysis » Discrete choice modeling (incl. stated choice experiments) » Evaluation techniques for decision making » Survey methodologies. <p>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.</p> <p>The course consist of a series of lectures and literature study. Each lecture is complementary to the literature studied and accompanied by a practical where the students apply the theory to a case.</p>	

Technology Entrepreneurship	
Responsible lecturer	Dr. A.S.A. Bobelyn
Course code	1ZM20
Period	2
ECTS	5
Course description:	
<p>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.</p> <p>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 fulfilment.</p>	

Built Environment and Smart Mobility	
Responsible lecturer	V. Caiati MSc
Course code	7ZW4M0
Period	4
ECTS	5
Course description:	
<p>This course deals with analyzing 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:</p> <ul style="list-style-type: none"> • The complex interdependencies involved • Effects on the environment, functioning of the system and quality of life • The reason for success or failure of adopting smart (shared) mobility from demand and supply perspective. <p>The following topics will be dealt with:</p> <p>Built Environment and Transportation: relations between transportation, land use, urban design and real estate; activity-based analysis as integrated framework.</p> <p>Real estate, accessibility and transportation: concepts of destination and reach; measurement of accessibility; cumulative opportunities; gravity measures; space time prisms; consumer surplus; empirical studies on impact of accessibility on land and property values and the impact of parking in office and shopping center developments.</p> <p>Urban form and travel: Space Syntax; models of pedestrian flows; walkability indices.</p> <p>Transportation, environment and quality of life: activity travel patterns and energy consumption, emissions and exposure; mobility; well-being.</p> <p>Models of transport demand: the 4 step model; activity-based models (constrained based models, utility-maximizing models, computational process models).</p> <p>Mobility as a service (MaaS), challenges, progress and prospect.</p> <p>Smart mobility: more capacity vs. better use; developments in travel information; effects of travel information on activity travel patterns; new technology and smart grids</p>	

Entrepreneurial Marketing	
Responsible lecturer	Dr.ing. J.P.M. Wouters
Course code	1ZM120
Period	2
ECTS	5
Course description:	
This course:	
<ul style="list-style-type: none"> » 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 	
<p>Topics in this course are the introduction to marketing-entrepreneurship interface, the technology adoption life cycle (TALC), and the entrepreneurial marketing plan.</p>	

Research and Development Project	
Responsible lecturer	Dr. G.Z. Dane
Course code	7ZM1M0
Period	1,2,3,4
ECTS	10
Course description:	
<p>Executing a Research and Development project for a specific case in the research areas of Energy Neutral Cities, Urban Management and Building Information Modeling within the Smart Cities concept.</p>	
<p>Firstly, a research and/or development problem is identified by each student. These research and/or development problems can follow from an on-going project in the DDSS (Design and Decision Support Systems) research group (https://www.tue.nl/universiteit/faculteiten/bouwkunde/onderzoek/onderzoeksprogrammas/design-and-decision-support-systems/research/ddss/), but also from society or industry. In the given time frame, goals and criteria of the project are specified to solve the defined problem.</p>	
<p>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 the state-of-the-art in DDSS research projects such as Discrete Choice Analysis; Regression Analysis; Bayesian belief networks; Building Information Modeling; Geographical Information Systems; Linear Programming. In addition, Information Systems Lab facilities (such as virtual reality lab and 3D printer) are available to support the experiments of students. With support from the staff, these new methods/techniques are learned by doing. The results should be interpreted by the student taking into consideration the pre-defined criteria. Finally, a scientific report is written that reflects upon the achieved results.</p>	

Smart Healthy 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).

The course consists of a series of lectures. Each lecture addresses a particular topic and is accompanied by a practical and assignments where the students apply the theory to a case.

The following topics are addressed:

- » Current issues in urban planning and the need for smart solutions (health, social, mobility, energy)
- » The need of integrated land-use and transport planning and creating benefits by synchronizing networks
- » Applications and potential of integrating ICT in urban infrastructure and personal information systems
- » Techniques and applications of data mining to extract information from big data
- » Techniques and applications of knowledge-based systems for urban planning

Project Big Data 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), ageing (social exclusion, social satisfaction), and tourism (crowding). In this project you consider a planning problem of your choice and apply a suitable approach to better understand the problem and evaluate scenarios.

The approach includes Information from a big database such as GPS data, Twitter data or one of the large national surveys, such as OVIN. These databases provide rich information on micro-level of individuals. In this approach an existing database, or combination of databases is analysed to achieve a better understanding of behaviour of individuals with regard to the planning problem considered. During the project the following steps will be carried out: formulation of a research question; literature research; specification of a conceptual model; identification of relevant variables; preparation of the data; performing the analysis and interpreting the results. The analysis technique and database used will be chosen depending on the research question. The emphasis is on advanced techniques from the field of either regression modelling (e.g., path analysis) or data mining (e.g., Bayesian network learning).

Fundamentals of BIM

Responsible lecturer	Dr. P. Pauwels
Course code	7M900
Period	2
ECTS	5

Course description:

This course is of importance to everyone handling building information 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 particular, BIM has become a generally accepted method in the construction industry including civil engineering and building services. Through BIM processes and BIM tools, one is able to represent building information in a comprehensive model and exchange all building information with peers in the building life-cycle. BIM models are nowadays created for different purposes with different aspects for a wide range of applications throughout the lifecycle of buildings, ranging from simple geometric models to detailed building component specifications.

In this course, the student is introduced to various data and information modelling techniques of use in combination with mainstream BIM tools and processes. The course starts with an introduction to BIM and to the conceptual modelling language UML. UML can be used to specify interaction diagrams as well as information management diagrams and thus is a crucial tool for the data scientist. Furthermore, several very different data modelling and information modelling techniques are taught in detail, including XML/XSD, relational databases (MySQL), EXPRESS and IFC, and graph databases (Neo4J, RDF, OWL). The student learns to use and apply each of these data modelling techniques through practical and relevant construction-related examples and assignments. The final assignment and lectures teach the student how to use these data models and techniques in state-of-the-art software development environments, using Python as a reference scripting language.

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 other countries. 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 centers. 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

Inner-city modular high-rise

Responsible lecturer	Prof. dr. ir. T.A.M. Salet
Course code	7RC100
Period	1
ECTS	5

Course description:

Inner-city Modular High-rise (previously known as 'Procurement') is one of the three courses that together form the Construction Technology certificate program. The course addresses the issues of tendering, design and realization from a contractor's perspective, by describing the total process of a project. In addition to the relevance of social elements such as environment, circularity, structural design, costs, planning & logistics, and safety with the associated responsibilities. There is also attention for cooperation from the various disciplines in a construction process in order to ultimately making the difference.

Smart Building Methodology and Technology

Responsible lecturer	Prof. dr. ir. M. Mohammadi
Course code	7KP8M0
Period	3
ECTS	5

Course description:

Nowadays, technology advances at high speeds and building designers and engineers are faced with new technologies which applications are not always clear. On the other hand, the building industry is facing important challenges to meet climate agreements, while still providing healthy buildings in a human centric manner at realistic costs. This course aims at expanding the intellectual horizon of students regarding the application of emergent building methodologies and technologies to meet problems faced by our society. To achieve the objectives of this course, the theoretical approaches and building principles, outlined in the weekly lectures, are reinforced by their application in real-world problems.

For example, by applying AI-based solutions to design and develop smart cities, new housing typologies and using user-centered methodologies to understand real-life problems. The lecturers will provide an overview of recognized building principles, methodologies, concepts and approaches, and will discuss the application of state-of-the-art of technologies in architectural design. Every week has a specific theme on which the lecture and the weekly assignment will be presented.

Circularity in the Built Environment

Responsible lecturer	Ir. H. Schilperoort
Course code	7XC1M0
Period	1
ECTS	5

Course description:

This course introduces first of all circularity as the problem of planetary (resource) management, with a central role for rates and planetary boundaries. Energy, materials, waste and emissions are studied separately and in cohesion. Then we explore the idea of a circular economy, highlighting 21st century attempts to (re)define boundaries, “progress” and “costs” and consider fair distribution. We will study and exercise various circularity and sustainability assessments.

After this broad introduction we move on to the built environment and zoom in from large to small. What does circularity mean for planetary and urban spatial planning? How to design circular buildings on conceptual and technical level? How to redesign the numerous existing buildings that were not designed with these considerations? What is a circular product or component? And how to select materials? What should we know about their impacts, their availability, their mining and their recycling? After exploring these issues, you are asked to define 3 personal research questions in the domains of technology, economy and humanities.

GRADUATION IN EINDHOVEN

Graduation Project

Responsible lecturer	Prof.dr.ir. B. de Vries
Course code	7CC40
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 is focused on the management and implementation of information processes. The final graduation project has a clear scientific signature, and is grounded in actual smart buildings and smart cities challenges. CME graduation projects are often executed in collaboration with industry partners, engineering offices or government institutes. TU/e CME borrows from two scientific domains: (i) urban/building science and systems and (ii) management and innovation sciences.

Graduation options

The graduation project is executed on the cross 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). In the CME program, the following graduation topics are offered:

- » City Information Management
- » Building Information Management

Graduation consists of two parts: (1) Research proposal and (2) Graduation project. A student can only start his/her Graduation project after the Research proposal has been approved by the chair of the graduation committee.

Each graduation project will be guided by a group of specialized (assistant and associate) professors, preferably from both TU/e departments BE and IE&IS. The students work individually, while their projects concur with research themes related to research and development activities of the involved staff and PhD's.

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, built 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

Profile: Markets and Organization in Construction	Profile: Digital Technologies in Construction
Profile courses minimum 30 EC	Profile courses minimum 30 EC
<ul style="list-style-type: none"> - Research Methodology & Academic Skills - Planning and Process Management - Legal & Governance Aspects - Sustainable Transportation Infrastructure - Construction Industry Dynamics - Construction Process Management - Circular Systems Engineering - Infrastructure Asset Management 	<ul style="list-style-type: none"> - Research Methodology & Academic Skills - Planning and Process Management - Legal & Governance Aspects - Construction Industry Dynamics - Construction Process Management - Circular Systems Engineering Digital Technologies in Construction - Technology and Innovation in Road Construction
Elective profile courses	Elective profile courses
<ul style="list-style-type: none"> - Construction Supply Chains and Digitization - Safety by Design for Products, Equipment and Systems - Urban Resilience in a changing climate - Procurement Strategies and Tendering - Value Management - Culture in Construction - Structural Health Monitoring for smart infrastructure - Governing Product development (IDE) - Maintenance Engineering and Management (ME) - Infrastructure Maintenance Machines (ME) - Product Life Cycle (IDE) - Scenario based product design (IDE) - Cost Management and Engineering (IEM) - Product Life Cycle Management (IDE) - Design for Maintenance Operations (IDE) - Advanced 3D Modelling (IDE) - Virtual Reality (IDE) - Advanced Inventory Management (IEM) - Lean Six Sigma Green Belt (ME) 	<ul style="list-style-type: none"> - Sustainable Transportation Infrastructure - Construction Supply Chains and Digitization - BIM and 5D Planning - Simulation and Optimization of Construction Processes - Safety by Design for Products, Equipment and Systems (ME) - Value Management - Subsurface Infrastructure Engineering - Infrastructure Asset Management - Structural Health Monitoring for smart infrastructure - Maintenance Engineering and Management (ME) - Product Life Cycle (IDE) - Scenario based product design (IDE) - Cost Management and Engineering (IEM) - Product Life Cycle Management (IDE) - Design for Maintenance Operations (IDE) - Advanced 3D Modelling (IDE) - Virtual Reality (IDE) - Advanced Inventory Management (IEM) - Lean Six Sigma Green Belt (ME)
Electives (maximum 15 EC)	
<ul style="list-style-type: none"> » Any course from UT or approved other university* 	
Thesis (35 EC)	
<ul style="list-style-type: none"> » Preparation MSc-thesis (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.

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	201800040
Period	2
ECTS	5
course description:	
<p>While working on their master thesis many students face the challenge to define the research problem, design the 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.</p> <p>The course prepares students during the preparation phase of their master thesis assignment to cope with the practical problem of the assignment and the design of researching the problem. It provides students with the opportunity to develop and improve their academic skills and allow them:</p> <ul style="list-style-type: none"> • to acknowledge, observe and describe the problematic situation, • to communicate to people involved over this situation, • to formulate this problem in a comprehensive and clear way to the point that it can be formulated as a researchable problem • to work out a research design and plan and present them convincingly. 	

PROFILE COURSES

Legal & Governance Aspects	
Responsible lecturer	Dr. P.J. Klok
Course code	201900107
Period	1
ECTS	5
Course description:	
<p>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.</p> <p>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.</p> <p>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.</p>	

Planning & Process Management	
<i>Responsible lecturer</i>	Dr. M. van Buiten
<i>Course code</i>	201800072
<i>Period</i>	1
<i>ECTS</i>	5
Course description:	
<p>This course focuses on (transport) infrastructure planning and process management of transport 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.</p> <p>This course has two main parts: strategic transport planning and process management. The first part provides an overview of the role, contents and implications of strategic transport planning. The course follows the elements of the policy cycle. The transport policy cycle represents an iterative process with many actors going through the stages of Problem recognition, Formulation of policy objectives, Appraisal of policy options, Implementation, Monitoring and Evaluation. We discuss why the theory of the policy cycle is not or only partly implemented in practice. In this part, students review and discuss the strengths, limitations and weaknesses of state of the practice strategic transport planning frameworks.</p> <p>The second part, process management, focuses on the governance of intricate problems in urban planning and area development. It typically revolves around large-scale infrastructure projects, e.g. airports, rail links, or ports. Such projects require the collaboration of many actors within a complex and dynamic environment. The environment includes various social, political and physical factors, and actors related to a project, such as decision makers, regulators, risk taking participants and stakeholders. These actors each have different interests, resources and attitudes towards a project. Each influences and is affected by a project in different ways and to different degrees. This part of the course 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.</p>	

Sustainable Transportation Infrastructure	
<i>Responsible lecturer</i>	Dr. J.M. Oliveira dos Santos
<i>Course code</i>	202200057
<i>Period</i>	1
<i>ECTS</i>	5
Course description:	
<p>This course addresses Sustainability of transportation infrastructure and built environment in a broad sense with particular attention for the economic, environmental and social aspects. Sustainability is achieved when the whole society has the capacity and opportunity to maintain and improve its quality of life without degrading the quantity, quality and availability of economic, environmental and social capital.</p> <p>With the increasing evidence of global warming due to greenhouse gas emissions and the reduced availability of natural resources, the pressure to ensure that transportation infrastructure can provide the mobility of people and goods—advancing economic and social development to benefit today's and future generations—in a manner that is safe, affordable, accessible, efficient, and resilient, while minimizing environmental impacts is of paramount importance. Sustainable transportation infrastructure represents the future direction of the profound transformation in the transport system in order to address these challenges in a balanced way. In this context, civil engineers need to be armed with skills than enable them to develop and apply ways, means, and methods to study and analyze the design, construction and management of transportation infrastructure towards improving their sustainability level.</p> <p>This course is delivered in a very practical way in which students have to assess the sustainability degree of a given transportation infrastructure and propose solutions to improve its sustainability during the analysis period. Through this hands-on approach, students will be able to apply the "instrumentations of sustainability" while accounting for the trade-offs inherent to the concept of sustainability and considering technical constraints and requirements.</p>	

Construction Industry Dynamics	
Responsible lecturer	Prof.dr.ir. A.G. Doree
Course code	201800047
Period	2
ECTS	5
Course description:	
<p>The construction industry provides infrastructures crucial for our society as roads, canals, energy networks, sewage systems, flood protection). These infrastructures keep us safe, healthy and prosperous. The Industry has to respond to the challenges and need of our societies. Central in this course is the way and pace the stakeholders in the construction industry deal with competition, and develop and absorb new technologies (eg ICT, BIM, GIS) and new challenges (eg sustainability, social responsibility). This knowledge and understanding is put into the context of the strategic choices of the stakeholders, and the international initiatives undertaken to reform the construction industry. The course focuses on the issue of changes in contract types and procurement, and the effects on strategies and innovation in agencies and firms. It explains the relationships between market regulation, competition, market dynamics and innovation at the level of the industry and the organizations within. It also addresses the issue of business paradigms and strategic management for firms in the construction industry.</p>	
This Course addresses the following topics:	
<ul style="list-style-type: none"> • Outlook to the future: World Economic Forum's "Infrastructure and Urban Development Industry vision 2050") • A narrative of the changes in the construction industry over the past five decades (to provide context) • Theories and logics used to explain the relationships between industry characteristics, strategic choices and industry dynamics • Papers on markets, competition, regulation and industry dynamics (to provide insight into dynamics beyond change in the entrepreneurial environment) • Papers on obstacles for innovation due to structure and culture of the construction industry (particularly to provide insight into the systemic barriers to change and innovate due to fragmented supply chain, project wise production, procurement and adversarial relationships) • Papers on Complex product industry and the "systems integrator" business model (to provide insight is to an integrated business model for construction industry) 	

Construction Process Management	
Responsible lecturer	Prof.dr.ir. L. Volker
Course code	201800029
Period	3
ECTS	5
Course description:	
<p>To be able to analyze and design the organizational processes of complex construction projects, by exploring different theories, tools, techniques and methods that deal with the integration of time, costs, quality, information, and organization in a project-based environment.</p>	
<p>The course focuses on complex construction processes, used in the initiative, design, realization and operation of construction projects. By analysing and interpreting the specific challenges and characteristics within each phase, the course teaches the student to optimize and manage this kind of processes. Decision-making is based on the use of well-known tools, balancing them against the interests and risks of the stakeholders and shareholders of projects. Guest lectures will show how these processes are done in practice. The theoretical concepts will be dealt with during regular lectures and student assignments. Active participation of students and group work is expected during the lectures.</p>	

Circular Systems Engineering	
Responsible lecturer	Dr.ir. M.C. van den Berg
Course code	202200043
Period	3
ECTS	5
Course description:	
<p>The main focus of this course is to teach students how to design circular civil engineering objects with the use of Systems Engineering (SE). SE is a universal design method, which is prescribed by the main Dutch clients in the civil engineering industry (Rijkswaterstaat and ProRail). SE consists of a structured sequence of steps to make a design. These steps progress from initial ideas, via the analysis of requirements and functions, to the design of a fully functioning system that performs its intended goals. A Circular Economy (CE) refers to a regenerative economic system in which materials are reduced, reused and recycled.</p> <p>This course explores the application of circularity principles in SE design projects. It comprises a series of (guest) lectures, a workshop and a design project that will help students to learn designing a circular civil engineering object with SE. The topics are assessed by means of an individual exam (50%) and a group design project (50%).</p>	

Infrastructure Asset Management	
Responsible lecturer	Dr. A. Hartmann
Course code	201800034
Period	4
ECTS	5
Course description:	
<p>Infrastructure asset management (IAM) involves activities and decisions that reduce the expenditures over the life-cycle of an infrastructure asset while extending the period for which the asset provides its required performance. It focuses on three main questions: the why, when and what of activities and decisions.</p> <ul style="list-style-type: none"> • The “why” concerns the objective or purpose of infrastructure. An infrastructure asset represents a resource used by an organization (e.g. public agency) to deliver services to its customers or run its production processes. By defining infrastructure objectives the importance of an asset for an organization and its role for the organization’s business can be determined. • The “when” addresses the performance of infrastructure. An infrastructure asset wears out over time and can reach a critical stage of undesired performance. By analyzing the development of functional and technical performance of infrastructure the point in time when the performance of an asset becomes critical can be identified. • The “what” deals with the kind of interventions throughout the life-cycle of an infrastructure asset. Interventions may include preventive and corrective maintenance, renovation or (re)building. <p>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.</p>	

Digital Technologies in Construction

Responsible lecturer	dr. X. Yin
Course code	201800044
Period	3
ECTS	5

Course description:

Digital technologies are changing the world around us with a force and pace unmatched in the modern human history. Such technologies as digital twins, laser scanning, drones, robotics, artificial intelligence, embedded sensors, ubiquitous computing, Internet of Things, and 3D printing have already reshaped and pushed the boundaries of productivity, safety, and quality in many industries. For the fragmented construction industry, it remains a significant challenge to keep abreast with these new developments. Recently, companies in the construction industry have started to explore and exploit the true potentials of digital technologies to remain competitive in the fierce market. Companies develop pilot projects with data-driven solutions to improve processes at different phases of construction projects' lifecycle. This strengthens the general notion that the development, adoption, and integration of tailor-made and customized digital technologies will be the future for construction industry.

This course focuses on the implementation and potential (disruptive) impact of digital technologies in civil engineering. It provides a broad-brush overview of digital technologies in the construction industry and ways in which they can improve 'conventional practices'. Besides receiving this overview-knowledge through lectures, students will learn how to draw a roadmap for the future of a domain in the construction industry through a group project. They learn how digital technologies can be used in the fragmented industry to achieve more integration and support productive, safe, and high quality civil engineering projects.

This course reviews the application of various types of design and data modelling applications (3D, 4D BIM, GIS), and data capturing technologies (e.g., sensors, GPS, inertial measurement unit, infrared camera, accelerometers) in the construction industry. In doing so, this course will touch on topics such as wearable technologies, ubiquities computing, embedded sensors, Internet of Things, connected and smart construction site and real-time operator guidance systems.

Additionally, this course discusses how these digital technologies support real-time and data-driven decision making throughout the lifecycle of construction projects. Various data analysis, simulation, visualization, and optimization methods that are used to address challenges in the construction industry will also be discussed.

Technology & Innovation in Road Construction

Responsible lecturer	dr. S.R. Miller
Course code	201800052
Period	4
ECTS	5

Course description:

Road construction processes are often described as being traditional where work methods are based on implicit knowledge and custom, leading to extensive variability in the final constructed road. Process control is defined as those activities involved in ensuring a process is predictable, stable, and consistently operating at the target level of performance with only normal variation. The goal therefore is to ensure that the process variability inherent in the asphalt construction process as a result of the custom-based work practices, is reduced to within acceptable limits. This requires that the construction process is explicit, meaning that key process parameters such as temperature homogeneity and compaction are measured, visualised and improved upon in a scientific manner. This course focuses on how new sensor technologies and innovations can be integrated into construction processes in order to reduce process variability and improve overall quality. Using the case of asphalt construction, students are taught the fundamentals of process control with the main goal of reducing process variability.

The main topics covered in this course are:

- » Fundamentals of process control
- » Asphalt mix design to construction and maintenance – the need for science-based approaches
- » Measuring variability in construction processes – a sensor-based approach
- » Integrating sensors and innovative technologies to improve process control
- » Visualization and Simulation tools for construction processes
- » Using sensor data to apply Statistical Process Control techniques in Quality Control
- » Integrating real-time systems into method-based operational strategies

GRADUATION IN TWENTE

Preparation Master Thesis	
Responsible lecturer	M. Hamhuis
Course code	201800115
Period	-
ECTS	5
Course description:	
<p>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.</p> <p>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.</p> <p>Based on this plan the student will deliver the following products:</p> <ul style="list-style-type: none">» 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:	
<p>The student will have to prove that he/she meets the objective of the program, 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.</p> <p>The student will do an individual 6 months project in the field of civil/construction engineering. It can either be a research project or a systematic design (of a model, object or procedure). It is preferred that the assignment is executed externally at a company or an institution. The assignment can, however, also be executed internally at one of the departments of CiT, for example at a research project that contributes to a PhD dissertation.</p>	

