

CoMEM Handbook

The Study Guide 2016-2017

CoMEM Study Guide 2016-2017

EMMC CoMEM

Study Guide

This document is valid for the academic year 2016 - 2017. Each academic year this handbook is revised and amended. The updates are in accordance with local study guides at the consortium partner universities. The aim of the revisions and amendments is to ensure the continuous implementation of best practices, enhance course integration, and thereby heighten the quality of CoMEM.

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CoMEM Study Guide 2016 - 2017

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CoMEM Study Guide 2016 - 2017

The EMMC CoMEM

Congratulations on your decision to participate in the most exciting educational opportunity in the field of coastal and marine engineering and management! The Coastal and Marine Engineering and Management programme (CoMEM) is one of the European top-quality Masters courses selected by the European Commission Erasmus Mundus programme. Erasmus Mundus, which is a co-operation and mobility programme, both promotes the European Union (EU) as a centre of excellence in higher education around the world and supports European top-quality Masters Courses.

We are delighted to welcome you to CoMEM, a two-year, English taught international Master's programme, in which five high-rated European universities participate: The Norwegian University of Science and Technology (NTNU), Technical University of Catalonia (UPC), Delft University of Technology (TUD), University of Southampton (SOTON) and City University of London (City).

CoMEM - is a full-time Master of Science Degree programme. During these two years, you will study at two or three of the partner universities. During the CoMEM years of study, you will have the opportunity to explore new frontiers of science and technology and make friends for life.

The intention of this guide is to present to students the curriculum for each of the five CoMEM tracks. The CoMEM programme aims in achieving smooth transitions between institutions so that you as a student can focus on studies and research.

CoMEM Consortium Universities

In this section the five partner institutions are presented. Each institution is a recognized leader in the field of coastal and marine engineering and management.

The Norwegian University of Science and Technology – NTNU

<http://www.ntnu.no/>

NTNU was established in 1996 as a further development of the University of Trondheim (UNiT). The university itself, founded in 1910, has contributed a solid century of academic achievements and discoveries that have shaped Norwegian society. NTNU has seven faculties and 48 departments. It is a university with a broad academic scope that has its main focus on technology and the natural sciences. The university has 23 000 students of which about 11% come from other countries and 5000 staff which over half in academic or scientific positions. NTNU is Norway's primary institution for educating MSc-level engineers. NTNU is located in Trondheim, about 500 km north of the capitol Oslo, Norway.

Technical University of Catalonia BarcelonaTech – UPC

<http://www.upc.edu/>

Although antecedents of the University existed that, in some cases, went back to the mid- 19th century, UPC itself was founded in March of 1971 and was originally known as the Universitat Politècnica de Barcelona. UPC is a public university that specializes in the fields of architecture, engineering, merchant seamanship, economics, health sciences and applied mathematics. The University has approximately 2,800 teaching and research staff, 33,000 students and 3000 PhD students. Its location is at the Mediterranean north east Spain.

Delft University of Technology – TUD

<http://www.tudelft.nl/>

Delft University of Technology was established on January 8, 1842. TU Delft collaborates with a large number of other educational and research institutes within the Netherlands and abroad and has a reputation for high quality teaching and research. The student body is made up of over a 100 nationalities. TU Delft is located in Delft and has approximately 2,600 researchers, 17,000 students and 2000 PhD students.

University of Southampton – SOTON

<http://www.soton.ac.uk/>

The University of Southampton located in the southern UK and is organised into eight Faculties, each housing a number of academic units. Collectively, the two Faculties of Engineering and the Environment and Natural and Environmental Sciences hosting CoMEM consists of 3,120 undergraduate, 350 taught and 710 research postgraduate students. They have 580 academic and 270 other staff. At SOTON as a whole there are currently more than 20,000 students enrolled.

City University, London – City

<http://www.city.ac.uk/>

City is one of the most international universities in the UK with more than 21,000 students from over 160 countries and staff from over 50 countries. More than 100,000 former students from over 150 countries are members of the City Alumni Network. Once you graduate you'll be eligible to join them. Our location is in the heart of London. City is the fifth largest higher education establishment within central London. The Lord Mayor of the City of London is our Chancellor. In 2016, City University will join the Confederation of the University of London as a self-governing college.

Five tracks of CoMEM specialization

Engineering has significantly advanced in the last decades and can now act with a level of tools and calculation methods never available before. At the same time it is subject to economic constrains much more difficult than before. Coastal environments in Europe and worldwide have suffered an important degradation during the last decades and their maintenance is becoming particularly difficult due to the increase of human pressure and because of the long lasting economic crisis in which we are immersed. Additionally the cultural, legal and administrative settings vary from country to country even within the European Union. This variety of environments, legislations and cultures, together with the technical, environmental and economic constrains, pose a challenge that the CoMEM students should be able to face. The well designed combination of topics, theory and practices within each Track of CoMEM

prepares the students for such challenges. The Tracks give the students a choice – and with the choices comes mobility. The distinctive skills offered by the five partners are brought together within each Track. These can only be accessed by student mobility. The unique mobility path per track is content driven and follows the location of expertise and curriculum integration. The mobility of the students is justified by the underlying premise that the best use of the resources of each partner university can be achieved by the students immersing themselves in the unique geographical/coastal environment of the universities of each track. In addition, mobility ensures student social integration. As such, five unique and integrated study Tracks are defined:

- 1: Arctic Marine Coastal Engineering (NTNU)
Track tutor: Associate professor Raed Lubbad <raed.lubbad@ntnu.no>
- 2: Marine Operations and Management (City, London)
Track Tutor: Professor John Carlton <John.Carlton.1@city.ac.uk>
- 3: Environment and Management (Southampton)
Track tutor: Professor Robert Nicholls <r.j.nicholls@soton.ac.uk>
- 4: Coastal Engineering (TU Delft)
Track tutor: Professor Paul Visser - CITG <P.J.Visser@tudelft.nl>
- 5: Engineering and Environment (UPC, Barcelona)
Track tutor: Professor César Mosso Aranda <cesar.mosso@upc.edu>

A schematic representation of the structure of the programme is presented in Figure 1.

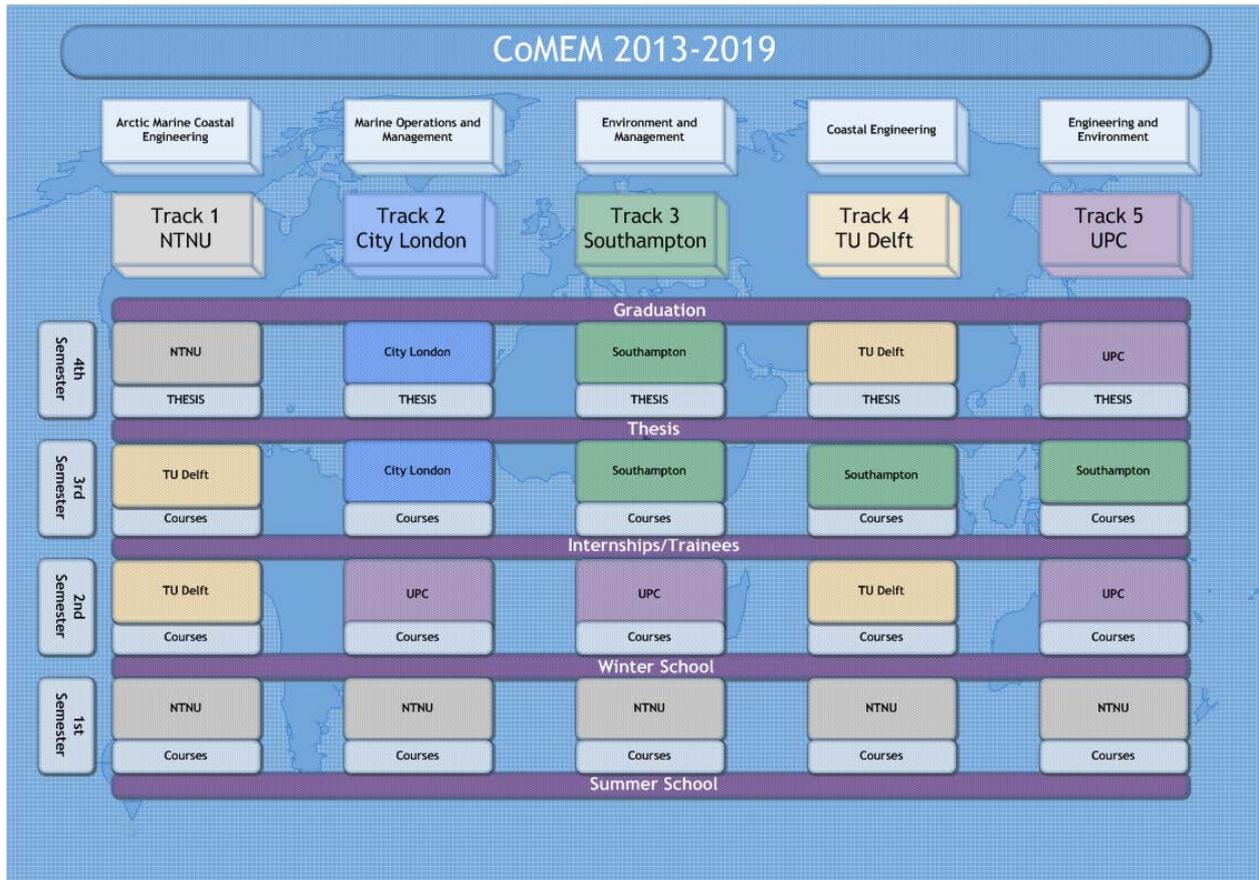


Figure 1 – Structure and mobility of the programme and specializations tracks.

CoMEM track structure:

Year 1, first semester all students go to NTNU. Thereafter the students attend the partner institutions according to track choices. It is important to give this choice some consideration early on in your CoMEM programme at NTNU.

To create a balanced track of courses from the optional courses at each university, some courses are recommended and make a better fit than others. In order to make an informed decision you can find the descriptions and study loads of the courses in the tables presented below the track descriptions.

The CoMEM MSc consists of a study load of minimum 30 ECTS per semester, with a total of minimum 120. The optional courses are selected by the student in consultation with the CoMEM track tutors. Fundamental technical and scientific content is present in all tracks. The curriculum includes 7.5 ECTS on ethics which is compulsory. Courses in languages are offered as non-credit-bearing courses.

Mobility is content driven and ensures student social integration. The unique mobility path per track follows the location of expertise and curriculum integration, ensuring that: CoMEM students will be following existing courses in the academic calendar year, integrated with

students from other MSc programmes. The courses are integrated, so pre-requisite knowledge from different courses is assured and learning objectives are fulfilled.

Year 2, second semester, the CoMEM master programme is concluded with a master thesis work at the Home Track University. The five participating universities all have local rules and schedules for the MSc thesis project. The CoMEM partner universities have agreed on the following:

- The MSc thesis will take one semester (21 weeks);
- The MSc thesis carries a value of 30 ECTS
- Depending on the academic calendar of the year of the local universities, the date to hand in the MSc thesis is set between mid June to primo July.
- The assessment of the MSc thesis will be according to the local university rules.

According to the regulations of the MSc programme CoMEM, a student may only start the MSc thesis once he/she has completed at least 90 ECTS of the CoMEM MSc programme. At least 120 ECTS of CoMEM courses are required to obtain the Diploma certificate.

If the student meets this requirement he/she get permission to start the MSc thesis by submitting an application following the local rules of the home Track University. If the students' request has been agreed to, she/he can commence on the thesis work.

Didactic Approach

The student builds the specific knowledge of the MSc track and profile through courses, practical assignments and projects, complemented by internships and a supervised final MSc work. The consolidation of the theoretical content is made by a range of experimental and computational assignments. The multidisciplinary project in the second semester is important with respect to develop cooperative skills and active knowledge. To expose the student to the state-of-the-art and new challenges in coastal and marine engineering and management the programme is complemented by visits to on-going project sites and consultancy companies, and by guest lecturers from associated partners and experienced scholars in the programme.

MSc Multidisciplinary project

(TUD and UPC in the second semester)

Course description

The aim of this course is to resolve a not yet very well defined, but current coastal engineering problem in a team effort. Often problems are defined by society in such a way that it is not possible to start directly with finding a solution, first a proper analysis and description of the problem has to be made. You need to integrate sub-studies and alternative designs into a coherent entity, based on knowledge, understanding and skills acquired in the preceding semesters. Attention will be paid to quality control and the evaluation of the design process.

Goals

1. Learn to solve problems and to design in the field of CoMEM, working in a multidisciplinary setting;
2. Integrated use of knowledge and skills from previous years;
3. Application of knowledge and skills in designing from previous years;
4. Learn to work in an interdisciplinary setting;
5. Learn to apply elementary quality guarantee principles (e.g. MCE, SWOT) during the design process;
6. Learn to report, present and defend the final results of the project;
7. Evaluate what has been learned in the multidisciplinary and often multicultural work process.

Course type

The group and its individual members are responsible for the progress of the project, not the supervisor. So every few weeks the group should discuss its progress. Realise that when the report is ready in your head, it is still a long way before a presentable and readable printed copy is in the supervisor's mailbox. The supervisor gives hints on how to improve the work/report, but will in principle not give comments on the same issue more than twice. The supervisor is not responsible for the progress of the work and the contents of the report (that is the task of the group). The group makes an appointment with the supervisor every few weeks. Interim reports have to be handed over to the supervisor (or sent by Email) at least 24

hours before the meeting. During presentations, the supervisor acts as the client. Finally, the supervisor judges the work and gives individual marks.

MSc Thesis

Summary

This programme requires students to undertake independent, original and critical research on a relevant topic and to present the research objectives, methodology, analysis, results and conclusions effectively both orally and through the written Dissertation/Thesis.

Description and goals

Research topic can be selected from a list produced by the thesis university or decided by the student following agreement with a supervisor. Topics are allocated during fall the third semester. The thesis is an individual in-depth research or expert design project. Students can take an in-depth mono disciplinary thesis project or link his thesis to a multidisciplinary project. Background reading is required to identify clear objectives, methodology and the student should have a project plan within two weeks after start-up. Completion of a full dissertation is required within 21 weeks, with oral presentation(s) shortly before or after the submission of the thesis, following local rules.

Course type

There are no timetabled teaching sessions for this course, though regular meeting with supervisors are encouraged once every two weeks on average. 'Teaching' activities include the tutorials with the project supervisor and depend on the need for a seminar on research/presentation skills. Learning activities include the literature review and all aspects of the research and writing and production of the Dissertation/Thesis.

Learning Objectives of CoMEM

Overall learning outcomes of the CoMEM programme:

The aim of CoMEM is to provide the necessary technical and managerial skills, which are essential to undertake the challenges of current and future problems in coastal marine engineering and management worldwide. The output-based learning outcomes will provide:

- Familiarity with key issues concerning sustainable, environmental friendly, legal and economically acceptable solutions to challenges in Coastal and Marine Engineering and Management;
- An understanding of relevant ethical issues;
- Specific specialisation within one of the five tracks in the overall programme, including the MSc dissertation;

- A coherent and integrated global perspective on coastal and marine issues and problems;
- Understanding of the needs of industry and government agencies leading to significant employment opportunities.

More specifically the following knowledge, skills and general competences are relevant:

Knowledge:

Graduates with a degree in Coastal and Marine Civil Engineering will have:

- Broad and deep knowledge in science and engineering research and core engineering subjects;
- Broad and profound scientific and technical knowledge in selected areas of Coastal and Marine Engineering and Management;
- Understanding of relevant ethical and interdisciplinary issues (philosophy, integrated approaches, and multidisciplinary projects);
- Research skills appropriate for further academic study and continuous professional development;
- A European and global perspective on CoMEM issues;
- Ability to apply their knowledge in the development and innovation of the field in a social and interdisciplinary context;
- In-depth knowledge concerning sustainable, environmentally friendly, legal and economically acceptable solutions to challenges in Coastal and Marine Engineering and Management;
- An thorough knowledge and understanding of management and business practices and their limitations.

Skills

Graduates with a degree in Coastal and Marine Engineering and Management should be able to:

- Analyse and model complex coastal and marine engineering and management systems and processes;
- Develop management systems and products using scientific principles;
- Demonstrate innovation in the design of new coastal and marine systems including new processes and products;
- Understand the capabilities of computer-based and experimental methods for problem solving;

- Integrate knowledge of mathematics, science, information technology, design, business context and engineering practice to solve a wide range of problems in the subject applying understanding to novel and challenging solutions;
- Evaluate technical and financial risks, through an understanding of the basis of such risks;
- Assess ethical issues in coastal and marine engineering and management;
- Deal with multi-cultural workplaces;
- Master the fundamentals of the specific field of the track and to apply them to defined problems.

General Competences

Graduates with a degree in Coastal and Marine Civil Engineering should be able to:

- Practise a professional understanding and awareness with regard to knowledge, planning and executing research, adapted to changing circumstances and new knowledge;
- Work independently and in multidisciplinary teams, in collaboration with specialists and to take necessary initiatives;
- Communicate effectively the results of engineering work for both professional and non-experts;
- Recognize the need to evaluate and assess civil engineering work in a technological, ethical and social context, and take responsibility related to sustainability, the environment, the economy and social welfare;
- Understand the necessity to maintain professional competence through lifelong learning;
- Understand the limitations of the range of methods employed in coastal and marine engineering and management;
- Appreciate and respect the range of disciplines and their contribution to coastal R&D;
- Realise how research and science can contribute to improve coastal and marine safety and development;
- Contribute to the formulation and implementation of a research project;
- Be able to motivate decisions and to coordinate multi-disciplinary work;
- Be able to take responsibility for one's own work;
- Conduct work and demonstrate ethical and social responsibility;
- Act as an academic entrepreneur, defining new questions and research.

Specifications of the different Master tracks

(Course descriptions of each course offered are given on the CoMEM website:
<http://www.ntnu.edu/studies/mscomem/student-handbooks>)

Track 1 - Arctic Marine Coastal Engineering (NTNU)

Learning objectives Track 1

Knowledge

The Arctic Marine Coastal Engineering track provides students with the knowledge, skills and competencies for sustainable marine coastal development in the vulnerable Arctic region. The students will mostly acquire the knowledge on the environmental actions for the design of Arctic port, coastal and offshore structures at NTNU combined with the specialisation in coastal morphology at TU Delft. Thus, a graduate from the Arctic Marine Coastal Engineering Track will have a sound coastal engineering competence specialized in marine arctic engineering technology. The experience in coastal fieldwork undertaken in the Norwegian Arctic region combined with exposure to Coastal morphological issues in the Netherlands provides the necessary knowledge.

Skills

The engineering graduate from the track Arctic Marine Coastal Engineering may choose to obtain particular skills in:

- Developing analytical solutions
- Performing numerical analysis
- Conducting experimental work in a laboratory, e.g. cold room, ice tank, wave and current flumes.
- Carrying out field work and full-scale experiments in the Arctic areas

General competence

The engineering graduate has competence and insight into:

- Fluid mechanics, notably in relation to ocean waves and wave structure interactions
- Probabilistic design methods and risk management;
- Port, coastal and offshore structures
- Ice mechanics and physics
- Ice-structures interaction (actions and action effects)
- Assessment and estimation of the carrying capacity of floating ice for operations and transport
- Sea ice drift modelling
- Consequences of climate change in the arctic

List of Compulsory and Optional Courses of Track 1

Arctic Marine Coastal Engineering (NTNU)

This MSc track includes at least 120 EC, i.e. at least 30 ECTS in semester 1 at NTNU, Trondheim, at least 60 ECTS in total in semesters 2 and 3 at TU Delft and 30 ECTS in semester 4 at NTNU, Trondheim.

Track 1 courses in semester 1 (NTNU)

Compulsory courses:		ECTS
TBA4145	Port and Coastal Facilities	7.5
TBA4265	Arctic and Marine Civil Engineering	7.5
FI5205	Corporate Responsibility and Ethics	7.5

Optional courses:

TBA4275	Dynamic Response to Irregular Loadings	7.5
TMR4235	Stochastic Theory of Sea Loads	7.5
TBA5100	Theoretical Soil Mechanics	7.5

Recommended extra course:

Norwegian Elementary (NTNU Language Departments' online course)

Track 1 courses in semester 2 (TUD)

Compulsory courses:			quarter
CIE4061-09	Multidisciplinary Project	10	2.1 + 2.2
CIE4305	Coastal Dynamics 1	6	2.1
OE4680-12	Arctic Engineering	4	2.2

Optional courses:

Recommended:

CIE4309	Coastal Dynamics 2	5	2.2
CIE5308	Breakwaters and Closure Dams	4	2.1

Other optional courses:

CIE5307	Coastal Zone Management	3	2.2
CIE5312	Turbulence in Hydraulics	3	2.1
CIE5314	Flood Defences	3	2.2
OE4652	Floating Structures	4	2.1
OE5665-12	Offshore Wind Support Structures	4	2.2
OE5662	Offshore Wind Farm Design	4	2.1

Recommended extra course:

CIE4040-09	Traineeship (Internship)	10	summer
	Dutch Elementary	3	2.1+2.2

Track 1 courses in semester 3 (TUD)

Compulsory courses:

CIE4130	Probabilistic Design and Risk Management	4	1.2
CIE4310	Introduction to Bed, Bank and Shore Protection	4	1.2
CIE4340	Computational Modelling of Flow and Transport	4	1.1 + 1.2

Optional courses:

Recommended:

CIE5318	Fieldwork Hydraulic Engineering	4	1.1
CIE4330	Ports and Waterways 1	4	1.1 + 1.2
CIE4190	Analysis of Slender Structures	4	1.1
OE4651-12	Bottom Founded Structures	5	1.2

Conditional optional course

AT-327	Arctic Offshore Engineering (UNIS in October)	6	(1.1)
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Other optional courses:

CIE4115	Steel Structures 2	4	1.1
OE4606	Introduction to Offshore Engineering	3	1.1
OE4607	Introduction to Dredging Engineering	3	1.1
CIE4606	Geodesy and Remote Sensing	5	1.1
MT830	Applications of the Finite Element Method	3	1.2

Track 1 course in semester 4 (NTNU)**Compulsory course:**

TBA4920	MSc Thesis (Arctic Marine Coastal Engineering)	30	
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Conditional optional extra course

AT-307F	Arctic Offshore Engineering (Fieldwork)	3	
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Track 2 - Marine Operations and Management (City)*Learning objectives Track 2***Knowledge**

Track 2 combines the CITY focus on maritime operations, technology, maritime management, business, economics, finance, law, planning and accounting, and the NTNU studies on the description of the ocean environment and port and coastal issues with UPC's courses on sustainable coastal development for natural ecosystems and human safety aspects. Thus, the knowledge and skills obtained by students at NTNU and UPC will provide the scientific and technical foundations, which are necessary, to be able to undertake real projects. Such projects require knowledge of financial, technical, and legal issues and must be managed accordingly if they are to be successful. This track provides the students

with the knowledge and skills, which are necessary to take up positions of greater responsibility and to move from mainly operational to managerial and strategic positions.

Skills

The graduate from the Maritime Operations and Management track should obtain many skills and some of these are:

- Understand the fundamental technologies which underpin the maritime industry and their cost and effects on safety and the environment.
- Apply risk based methods and hazard identification to representative maritime situations.
- Develop analytical and management solutions for the key features which define maritime operations.
- Evaluate the important features of operational logistics.
- Understand the significant legal aspects of maritime problems and issues and the strategies to resolve such issues.
- Evaluate sources of legal advice, expertise and information for the implementation into management strategies and actions.
- Interpret the outcomes of financial policies and their impact upon resources.
- Develop methods of financial accounting for the measurement of profit, planning and control.
- Be able to evaluate the technical and operational implications of management decisions.
- Appraise the logistics role of shipping and ports in the global supply chain.
- Explain the economics and dynamics of freight markets.
- Interpret the various processes, procedures and practices for effective leadership and management of organisations.
- Evaluate proposals for the strategic management of resources and case preparation for the change management in the maritime environment.

General competence

Upon completing Track 2, the graduate should have acquired competence in the following:

- Maritime operations and technology and related business environments in which they work.
- Analysing the business, legal and economic environment for a service industry.
- Evaluating the design and operation of ships, offshore and related structures.
- Application of models of leadership and management to a range of maritime activities.

- Analysing the environmental impact of maritime activities and their influence upon the management of the amenity.
- Devising solutions to complex issues within maritime and business operations.
- Using inter maritime resources effectively for independent research and comment.
- Understanding the legal, economic and environmental frameworks in which maritime business operate

List of Compulsory and Optional Courses of Track 2

Marine Operations and Management (City)

This MSc track includes at least 120 ECTS, i.e. at least 30 ECTS in semester 1 at NTNU, Trondheim, at least 30 ECTS in semester 2 at UPC, Barcelona and at least 60 ECTS during semesters 3 and 4 at City, London.

Track 2 courses in semester 1 (NTNU)

Compulsory courses:		ECTS
TBA4265	Arctic and Marine Civil Engineering	7.5
TBA4145	Port and Coastal Facilities	7.5
FI5205	Corporate Responsibility and Ethics	7.5

Optional courses:

TMR4137	Sustainable Utilization of Marine Resources	7.5
TPK4120	Safety and Reliability Analysis	7.5
TBA4275	Dynamic Response to Irregular Loadings	7.5
TBA5100	Theoretical Soil Mechanics	7.5
TMR4235	Stochastic Theory of Sea Loads	7.5

Recommended extra courses:

Norwegian Elementary (NTNU Language Departments' online course)

Track 2 courses in semester 2 (UPC)

Compulsory courses:		
250600	Coastal Processes and Dynamics	5
250601	Coastal Sustainability: Defence and Realignment	5
250602	Coastal Zone Planning and Management	5
250603	Coastal Multidisciplinary Project: Sustainable Engineering in the Coastal Zone	6
250604	Design of Coastal and Harbour Structures: Deterministic and Probabilistic	3
250605	Impacts, Conflicts and Risks: Present and Future Conditions	3
250610	Port Management and Exploitation	3

Optional recommended course:

250608	Meteo-Oceanographic Time Series: Time and Frequency Analyses	3
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Recommended extra course:

	Spanish Elementary	3
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Track 2 courses in semester 3 (City)**Compulsory courses:**

EPM 782	Maritime Operations and Insurance EPM	7.5
EPM 783	Maritime Economics and Accounting	7.5
EPM 785	Maritime Management	7.5

Optional Courses:

EPM 784	Maritime Technology	7.5
EPM 786	Maritime Law	7.5
EPM 790	Environmental Issues	7.5
EPM	Risk Analysis	3.75
EPM	Security Studies	3.75
EPM 788	Port and Harbour Design and Management	3.75
EPM 791	Marketing of Marine Services	3.75
EPM	Offshore Studies	

Track 2 course in semester 4 (City)**Compulsory course:**

EPM 402	Dissertation. (Marine Operations and Management)	30
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Track 3 - Environment and Management (SOTON)*Learning objectives Track 3***Knowledge**

The Environment and Management track provides master students with the knowledge and skills necessary to work in coastal engineering consultancy with an emphasis on the environmental management dimensions, or to continue to PhD studies in this area. Track 3 provides the students with the foundation knowledge and understanding of coastal and marine engineering and management and more detailed understanding in coastal morphodynamics, coastal sediment dynamics, marine renewable energy, the application of GIS technology, and environmental risk assessment. Students from the Environment and Management track should acquire competences in soft coastal engineering and management related to Coastal and Maritime Engineering and Management in general.

This Track emphasises environmental and management issues: academics from both Civil Engineering and Oceanography contribute. The topics included include coastal morphodynamics, erosion, flooding and soft engineering, maritime engineering and marine renewables, environmental impact assessment and the use of GIS for coastal analysis: all these topics are available for theses, and placements are encouraged with industry such as HR Wallingford. Following this track, you will be able to deal with complex issues systematically and creatively and make sound judgements within the field of Coastal Engineering and Environmental Management.

The programmes at NTNU, UPC and SOTON are complimentary and allow a progression from the solid foundation in coastal engineering towards an emphasis on soft solutions and methods. This builds on SOTON's specialisation in soft engineering, shoreline management planning and preparing for sea-level rise and climate change in coastal areas. It includes applying important methods such as Geographic Information Systems (GIS), and Environmental Impact Assessments (EIA) related to the management of beaches, cliffs, and estuaries, as well as port and coastal studies, coastal protection systems and implementation of adaptation measures.

Skills

The graduate from the Environment and Management track should obtain a wide range of skills including:

- Understand the fundamental issues and methods which underpin environmental management and its consideration in coastal engineering.
- Apply these methods, including representative numerical models to analyse representative coastal situations and problems.
- Develop appraisal skills relevant to develop high level outputs which summarise these analyses, including proposing solutions.
- Evaluate the important and relevant features of coastal morphodynamics and its application to soft coastal engineering.
- Understand the range of management responses available to coastal engineers, including soft and hard protection, accommodation and retreat strategic options, and examples thereof.

General competence

Upon completing Track 3, the graduate should have acquired competence in the following areas:

- Understand the Environmental Management dimensions of coastal engineering and its application in a European context.
- Understand the full range of adaptation measures available for managing coastal areas, including retreat, accommodate and protect options.

- Understand the potential application of marine renewable energy, including its environmental dimensions.
- Be able to evaluate appropriate management responses for coastal problems taking account of multiple issues and integrating diverse data using techniques such as GIS and Environmental Risk Assessment.
- Understand innovative techniques such as shoreline management planning and selecting strategic long-term options in coastal engineering.

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List of Compulsory and Optional Courses of Track 3

Environment and Management (SOTON)

This MSc track includes at least 120 ECTS, i.e. at least 30 ECTS in semester 1 at NTNU, Trondheim, at least 30 ECTS in semester 2 at UPC, Barcelona and at least 60 ECTS in semesters 3 and 4 at SOTON, Southampton.

Track 3 courses in semester 1 (NTNU)

Compulsory courses:		ECTS
TBA4265	Arctic and Marine Civil Engineering	7.5
TBA4145	Port and Coastal Facilities	7.5
FI5205	Corporate Responsibility and Ethics	7.5

Optional courses:

Recommended:

TMR4137	Sustainable Utilization of Marine Resources	7.5
TPK4120	Safety and Reliability Analysis	7.5

Other optional courses:

TBA4275	Dynamic Response to Irregular Loadings	7.5
TBA5100	Theoretical Soil Mechanics	7.5
TMR4235	Stochastic Theory of Sea Loads	7.5

Recommended extra course:

Norwegian Elementary (NTNU Language Departments' online course)

Track 3 courses in semester 2 (UPC)

Compulsory courses:		
250600	Coastal Processes and Dynamics	5
250601	Coastal Sustainability: Defence and Realignment	5
250602	Coastal Zone Planning and Management	5
250603	Coastal Multidisciplinary Project: Sustainable Engineering in the Coastal Zone	6
250604	Design of Coastal and Harbour Structures: Deterministic and Probabilistic	3
250605	Impacts, Conflicts and Risks: Present and Future Conditions	3
250610	Port Management and Exploitation	3

Optional courses:

250608	Meteo-Oceanographic Time Series: Time and Frequency Analyses	3
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Recommended extra course:

	Spanish Elementary	3
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Track 3 courses in semester 3 (SOTON)

Compulsory courses:

CENV6084	Maritime and Coastal Engineering and Energy	7.5
CENV6126	Coastal Morphodynamics	7.5
CENV6139	Geographic Information Systems	7.5

Optional courses

ENVS6028	Environmental Impact Assessment	7.5
SOES3014	Coastal Sediment Dynamics	7.5

Track 3 course in semester 4 (SOTON)

Compulsory course:

CENV6149	MSc Thesis/Dissertation (Environment and Management)	30
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Track 4 - Coastal Engineering (TU Delft)

Learning objectives Track 4

Knowledge

The Coastal Engineering Track has its focus on the hard (rock) and soft (sand) Northern European coastal engineering provided by the programmes at NTNU and TU Delft, but distinguishes itself from Track 1 by the inclusion of soft engineering provided with the SOTON programme in the third semester. Graduates from this track will thus have a sound basic coastal engineering competence and in addition, instead of a competence in marine arctic engineering technology, a competence in soft engineering. Since there are quite a number of differences in coastal engineering problems in Norway, the Netherlands and the UK, graduates from this track will also have a much wider focus on coastal engineering issues compared to graduates from the individual partner universities.

Skills

The engineering graduate from the track Coastal Engineering is able to:

- Make an important contribution (technical and practical) to knowledge development, policy-making and implementation in the field of hydraulic engineering in general, with emphasis on the area of coastal engineering.
- Analyze all kind of coastal engineering problems in some depth.
- Represent and model these engineering problems and how to make from these representations hydraulic calculations,
- Find and formulate solutions to these problems, how to evaluate the problems and how to provide feedback.

General competence

The engineering graduate has knowledge of and insight into:

- Fluid mechanics, notably in relation to ocean waves and to flows in waterways, tidal inlets and along coasts;
- Probabilistic design methods and (flood) risk management;
- Numerical modelling;
- Morphology of coasts, dunes, estuaries and coastal inlets;
- Coastal structures (breakwaters, bank and shore protection works);
- Ports and waterways, including logistical processes.

List of Compulsory and Optional Courses of Track 4

Coastal Engineering TU Delft

This MSc track includes at least 120 ECTS, i.e. at least 30 ECTS in semester 1 at NTNU, Trondheim, at least 30 ECTS in semester 2 at TU Delft, at least 30 ECTS in semester 3 at SOTON, Southampton and 30 ECTS in semester 4 at TU Delft.

Track 4 courses in semester 1 (Trondheim)

Compulsory courses:		ECTS
TBA4265	Arctic and Marine Civil Engineering	7.5
TBA4145	Port and Coastal Facilities	7.5
FI5205	Corporate Responsibility and Ethics	7.5

Optional courses:

Recommended:

TMR4137	Sustainable Utilization of Marine Resources	7.5
TMR4235	Stochastic Theory of Sea Loads	7.5

Other optional courses:

TPK4120	Safety and Reliability Analysis	7.5
TBA4275	Dynamic Response to Irregular Loadings	7.5
TBA5100	Theoretical Soil Mechanics	7.5

Recommended extra course:

Norwegian Elementary (NTNU Language Departments' online course)

Track 4 courses in semester 2 (Delft)

Compulsory courses for all:			quarter
CIE4061-09	Multidisciplinary Project	10	2.1 + 2.2
CIE4305	Coastal Dynamics 1	6	2.1

Optional courses:

Recommended:

CIE4130	Probabilistic Design and Risk Management (not if TPK4120 completed in Norway)	4	
CIE4309	Coastal Dynamics II	5	2.2
CIE4310	Bed, Bank and Shoreline Protection	4	
CIE4340	Computational Modelling of Flow and Transport	4	
CIE5300	Dredging Technology	4	2.1
CIE5302	Stratified Flows	3	2.2
CIE5307	Coastal Zone Management	3	2.2
CIE5308	Breakwaters and Closure Dams	4	2.1
CIE5312	Turbulence in Hydraulics	3	2.1
CIE5314	Flood Defences	3	2.2

Other optional courses:

CIE4460	Polders and Flood Control	4	2.2
CIE5304	Waterpower Engineering	3	2.2
CIE5306	Ports and Waterways 2	4	2.2

Recommended extra course:

CIE4040-09	Traineeship (Internship)	10	summer
	Dutch Elementary	3	2.1+2.2

Track 4 courses in semester 3 (Southampton)

Compulsory courses for all:

CENV6084	Maritime and Coastal Engineering and Energy	7.5
CENV6126	Coastal Morphodynamics	7.5
CENV6139	Geographic Information Systems	7.5

Optional courses

ENVS6028	Environmental Impact Assessment	7.5
SOES3014	Coastal Sediment Dynamics	7.5

Track 4 course in semester 4 (Delft)

CIE5030	MSc Thesis (Coastal Engineering)	30
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Track 5 - Engineering and Environment (UPC)

Learning objectives Track 5

Knowledge

Track 5 of CoMEM follows the engineering and environment (“working with nature”) approach right from the beginning. It has been designed so students achieve a specialization by combining engineering projects fundamentals (NTNU and UPC) with environmental and managerial skills (SOTON). The mechanical concepts for the marine environment and coastal structures design introduced at NTNU are the basis for the advanced education and training at UPC in coastal dynamics and the implications these have for a) coastal protection and b) coastal management. SOTON adds more advanced morphodynamical concepts and the multiplicity of time and space scales that are required for coastal zone management. The diverse social, economic and technical environments from three different European countries are a separate objective. From Barcelona; the Latin administrative type of settings for a microtidal environment with moderate energy in the marine factors. From Southampton the Anglo Saxon administrative settings for a mesotidal environment with higher energetic driving terms. Finally from Norway; the Scandinavian type of administrative settings and a contrasting set of environments that go from exposed coasts to fiords. The required mobility will play a key role in this multidimensional education of the student and will allow a natural enrichment of their capacity to define and solve coastal problems.

Skills

The main objectives of the track Engineering and Environment are:

- Coastal dynamic processes and responses in microtidal environments, subject to sharp gradients (impulsive storm events, irregular topo-bathymetry, ...).
- Time series analysis for characterizing drivers and responses at short, mid and long time scales (including extremes).
- Multi scale analysis for water and sediment fluxes, going from turbulence to debris flows and including waves, currents and long period oscillations (illustrated by Mediterranean case studies).
- Risk, vulnerability and hazard analyses including the decadal (climatic) scale, discussing impacts, conflicts and risks.
- Engineering and environmental impact/mitigation for external harbours typical of a relatively straight coast (illustrated by Mediterranean case studies).
- Engineering and environmental impact/mitigation for open and pocket beaches in a context of sediment scarcity (illustrated by Mediterranean case studies).

General knowledge

The engineering graduate has knowledge of and insight into:

- Numerical models from the fields of coastal engineering and oceanography.
- Physical models for coastal processes, structures and their interactions.

- Field campaigns to evaluate models, equations and behaviour of structure in the coastal environment.
- Integration of physical drivers, morphodynamic response and perceived impact to assess coastal vulnerability within a sustainability framework.
- Cooperation with administrations and private companies to apply the new skills into actual coastal problem solving and planning cases.

List of Compulsory and Optional Courses of Track 5

Engineering and Environment (UPC)

This MSc track includes at least 120 EC, i.e. at least 30 EC in semester 1 at NTNU, Trondheim, at least 30 EC in semester 2 at UPC, Barcelona, at least 30 EC in semester 3 at SOTON, Southampton and 30 EC in semester 4 at UPC, Barcelona.

Track 5 courses in semester 1 (NTNU)

Compulsory courses:		ECTS
TBA4265	Arctic and Marine Civil Engineering	7.5
TBA4145	Port and Coastal Facilities	7.5
FI5205	Corporate Responsibility and Ethics	7.5

Optional courses:

Recommended:

TMR4137	Sustainable Utilization of Marine Resources	7.5
TPK4120	Safety and Reliability Analysis	7.5

Other optional courses:

TBA4275	Dynamic Response to Irregular Loadings	7.5
TBA5100	Theoretical Soil Mechanics	7.5
TMR4235	Stochastic Theory of Sea Loads	7.5

Recommended extra course:

Norwegian Elementary (NTNU Language Departments' online course)

Track 5 courses in semester 2 (UPC)

Compulsory courses:		
250600	Coastal Processes and Dynamics	5
250601	Coastal Sustainability: Defence and Realignment	5
250602	Coastal Zone Planning and Management	5
250603	Coastal Multidisciplinary Project: Sustainable Engineering in the Coastal Zone	6
250604	Design of Coastal and Harbour Structures:	

	Deterministic and Probabilistic	3
250605	Impacts, Conflicts and Risks: Present and Future Conditions	3
250610	Port Management and Exploitation	3

Optional courses:

250608	Meteo-Oceanographic Time Series: Time and Frequency Analyses	3
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Recommended extra course:

	Spanish Elementary	3
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Track 5 courses in semester 3 (SOTON)

Compulsory courses:

CENV6084	Maritime and Coastal Engineering and Energy	7.5
CENV6126	Coastal Morphodynamics	7.5
CENV6139	Geographic Information Systems	7.5

Optional courses

ENVS6028	Environmental Impact Assessment	7.5
SOES3014	Coastal Sediment Dynamics	7.5

Track 5 course in semester 4 (UPC)

Compulsory course:

31606	MSc Thesis (Engineering and Environment)	30
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