

September 2019

# **CoMEM Handbook**

## **The Study Guide 2019-2020**

CoMEM Study Guide 2019-2020

EMMC CoMEM

*Study Guide*

This document is valid for the academic year 2019 - 2020. 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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## The EMMC CoMEM

Congratulations on your decision to participate in the exciting educational opportunity in the field of coastal and marine engineering and management! The Coastal and Marine Engineering and Management programme (CoMEM) is a top-quality European Masters course selected for co-funding by the European Commission through the Erasmus+: Erasmus Mundus programme. Erasmus+: Erasmus Mundus is a joint mobility programme that promotes the European Union (EU) as a centre of excellence in higher education to the global community in addition to its financial support.

We are pleased to welcome you to CoMEM. The following five high-rated European universities jointly offer the English taught international CoMEM Master's programme,: The Norwegian University of Science and Technology (NTNU, Trondheim, Norway), Technical University of Catalonia (UPC, Barcelona, Spain), Delft University of Technology (TUD, Delft, The Netherlands), University of Southampton (SOTON, Southampton, United Kingdom) and City University of London (City, London, United Kingdom).

CoMEM - is a full-time, two-year Master of Science Degree programme. During these two years, the mobility tracks will enable you to study at two or three of the partner universities. The programme offers you the opportunity to explore new frontiers of science and technology and make lifetime friends.

The intention of this guide is to present to you 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 your 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, the Norwegian University of Science and Technology, has as its mission “Knowledge for a better world” and creates solutions that can change our daily lives.

In 2016, NTNU merged with the University Colleges in Gjøvik, Sør-Trøndelag and Ålesund to form a single university. The merger gives the university more comprehensive course offerings and larger research groups. NTNU is now Norway's largest, most exciting and innovative university. NTNU holds the broadest offer of study in Norway, through the diversity of technological, artistic and aesthetic disciplines. NTNU has 8 faculties, 55 departments and NTNU University Museum. NTNU annual budget is NOK 9 billion of which

NOK 2 billion from external sources. There are approximately 40000 students, of which half study technology and the natural sciences. In 2017, NTNU awarded 7210 bachelors and master's degrees and 362 doctoral degrees. The campuses offer approximately 120 laboratories. NTNU is Norway's largest participant in the EU's Horizon 2020 programme. The University has close cooperation with SINTEF, an R&D organization with 1800 employees (co-located with NTNU in Trondheim, and in Oslo). SINTEF is the largest independent research organization in Scandinavia with international top-level expertise in technology, medicine and the social sciences. The Times Higher Education ranked in 2017 the collaboration NTNU and SINTEF #1 in the world.

### **Technical University of Catalonia BarcelonaTech – UPC**

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

Although antecedents of the University go back to mid- 19th century UPC as it is known today was founded 1971. UPC is a public institution dedicated to research and higher education, specialized in the fields of architecture, science and engineering. UPC is committed to excellence, being a driver of economic and social change, and an institution that's extremely well connected to the productive fabric. The University has approximately 2,970 teaching and research staff, 33,000 students and 3,000 PhD students. Its location is at the Mediterranean north east Spain. UPC has over 200 research groups, 18 specific research centres, 18 TECNIO network research centres and 17 associated research centres. The turnover for R&D projects for 2014 was €50,318,740 and the 2015 UPC budget was €310,500,000.

### **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. TU Delft has numerous contacts with governments, trade associations, consultancies, industry and small and medium-sized companies. TU Delft believes its role in society is to supply technological solutions towards sustainability and a flourishing economy. TU Delft's mission is to make a significant contribution towards a sustainable society for the 21st century. TU Delft is located in Delft and has per 2015 over 2,900 researchers, almost 20,000 students and more than 2500 PhD students.

### **University of Southampton – SOTON**

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

The University of Southampton has a history back to 1862 and today is a global centre for excellence in research and education. SOTON is a research-intensive university and a founding member of the Russell Group of top research-focussed UK universities. They have gained prestigious recognition for our successes and history of world-changing achievements. The University of Southampton located in the southern UK is organised into five Faculties, each housing a number of Schools. CoMEM is hosted in the Faculty of Engineering and Physical Sciences (containing coastal engineering within the School of Engineering). CoMEM also receives contributions from the School of Ocean and Earth Sciences in the Faculty of

Environmental and Life Sciences which is based at the National Oceanography Centre. As a whole there are currently more than 23,000 students enrolled at the University of Southampton.

## City, University of London – City

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

City was founded in 1894 and has today five schools. City is one of the most international universities in the UK with more than 21,000 students from over 160 countries, staff from over 75 countries and alumni from 180 countries. City is located in the heart of London. The Lord Mayor of the City of London is our Chancellor. The total income for 2015 was £207.6 million. In 2016, City University joined the Confederation of the University of London as a self-governing college and is named City, University of London.

## 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 constraints 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 constraints, 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, Trondheim, Norway)  
Track tutor: Associate professor Raed Lubbad <raed.lubbad@ntnu.no>
- 2: Marine Operations and Management (City University, London, United Kingdom)  
Track Tutor: Professor John Carlton <John.Carlton.1@city.ac.uk>
- 3: Environment and Management (University of Southampton, United Kingdom)  
Track tutor: Dr Sergio Maldonado <S.Maldonado@soton.ac.uk>
- 4: Coastal Engineering (TUD, Delft, The Netherlands)



Track tutor: Professor Bas Hofland <B.Hofland@tudelft.nl>

5: Engineering and Environment (UPC, Barcelona, Spain)

Track tutor: Professor César Mosso Aranda <cesar.mosso@upc.edu>

Figure 1 shows a schematic representation of the structure of the CoMEM programme.

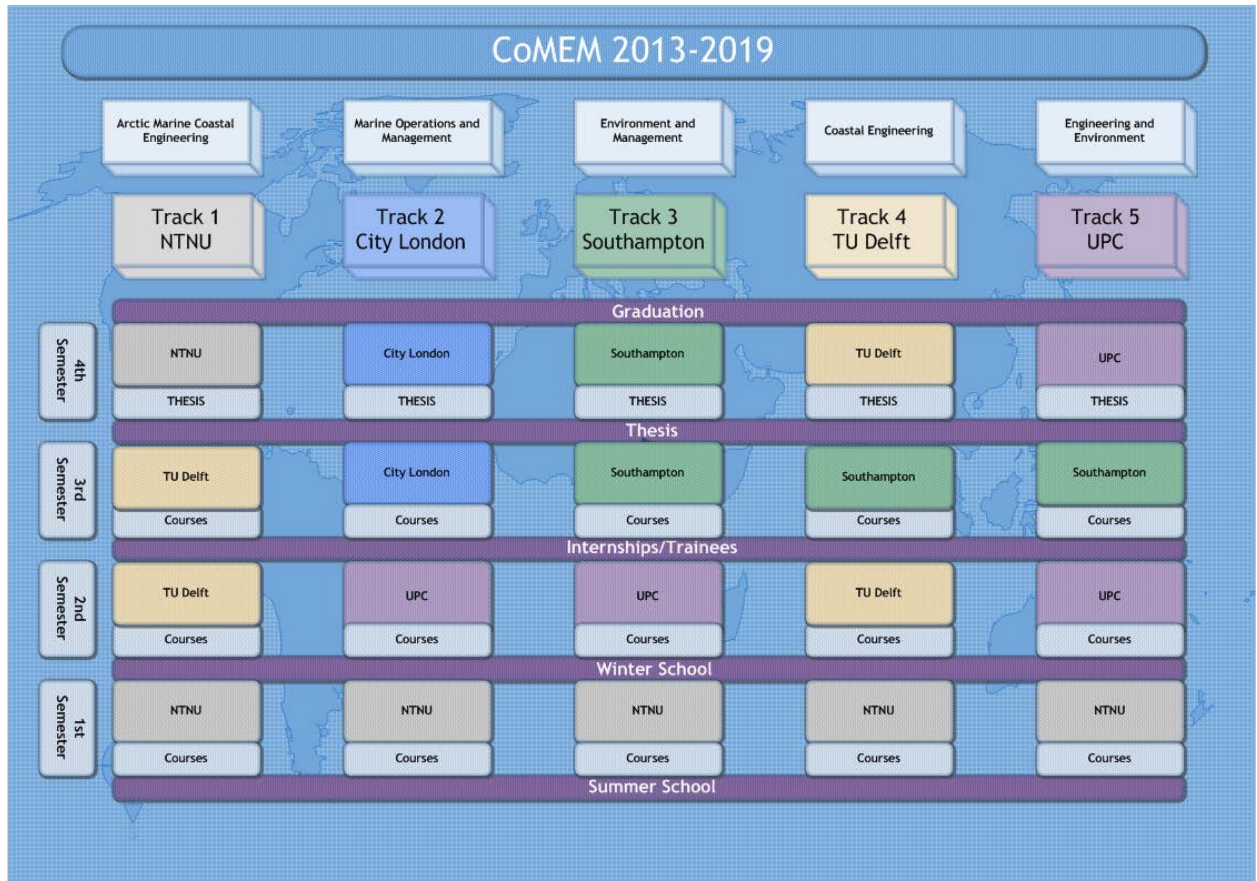


Figure 1 – Structure and mobility of the programme and specializations tracks.

## CoMEM track structure:

Year 1, first semester you will go to NTNU. Thereafter you attend the partner institutions according to track choices.

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 make. 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. You select the optional courses in consultation with the CoMEM track tutors. Fundamental technical and scientific content is present in all tracks. The curriculum includes



7.5 EC<sup>1</sup> on ethics, which is compulsory. The Partner Universities offer courses in languages as CoMEM extra non-credit-bearing courses. CIE4040-09 Traineeship (Internship) and AT-307F Arctic Offshore Engineering (Fieldwork) are extra courses, which credits do not count as part of the 90 EC ordinary coursework required in CoMEM.

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 EC
- The date to hand in the MSc thesis is set to the first week of July
- The assessment of the MSc thesis will be according to the local university rules.

According to the regulations of the MSc programme CoMEM, you may start on the MSc thesis after completion of 90 EC ordinary coursework of the CoMEM MSc programme. If you meet this requirement, you will be granted permission to start the MSc thesis by submitting an application following the local rules of the home Track University. Once your application has been granted, you can commence on your thesis work.

In the case you have not completed all ordinary coursework; you may apply for an exemption. Your supervisor and CoMEM Track Tutor must recommend the application addressed to the home track University. By recommending and signing the application, the supervisor and Track Tutor confirm that the remaining course(s) will not affect your ability to finish your master thesis in time. Be aware that you cannot have more than two remaining ordinary courses to complete. The remaining ordinary courses cannot be essential components in your master's thesis.

At least 120 EC of CoMEM courses (thesis included) are required to obtain the CoMEM Diploma certificates.

## Didactic Approach

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<sup>1</sup> EC is short for European Credits, and is used throughout this document instead of ECTS.

As student, you build the specific knowledge of the MSc track and profile through courses, practical assignments and projects, complemented by internships and a supervised final MSc work. A range of experimental and computational assignments makes the consolidation of the theoretical content. The multidisciplinary project in the second semester is important with respect to develop cooperative skills and active knowledge. To expose you 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. Therefore, 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 you to undertake independent, original and critical research on a relevant topic and to plan and 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 you following agreement with a supervisor. Allocation of topics should be done during fall in the third semester. The thesis is an individual in-depth research or expert design project. You can take an in-depth mono disciplinary thesis project or link your thesis to a multidisciplinary project. Background reading is required to identify clear objectives, methodology and you should have a project plan within approx. 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 the local university rules.

### Course type

Independent work with supervision. 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

The course descriptions

### Track 1 - Arctic Marine Coastal Engineering (NTNU)

#### Learning objectives Track 1

##### Knowledge

The Arctic Marine Coastal Engineering track provides you with the knowledge, skills and competencies for sustainable marine coastal development. Special attention is paid to the vulnerable Arctic region. At NTNU, you acquire the knowledge on the environmental loads for the design of port, coastal and offshore structures; this is combined with coursework in coastal morphology and offshore engineering at TU Delft. Thus, a graduate from Track 1 will have a sound coastal and marine engineering competence related to coastal technology in a harsh environment.

##### 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. wave and current flumes, cold room, ice tank
- Carrying out field work and full-scale experiments

##### 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
- Consequences of climate change

## 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 EC in semester 1 at NTNU, Trondheim, at least 60 EC in total in semesters 2 and 3 at TU Delft and 30 EC in semester 4 at NTNU, Trondheim. Only courses listed below counts.

### Track 1 courses in semester 1 (NTNU)

| Compulsory courses:     |                                     | EC  |
|-------------------------|-------------------------------------|-----|
| <a href="#">TBA4145</a> | Port and Coastal Facilities         | 7.5 |
| <a href="#">TBA4265</a> | Arctic and Marine Civil Engineering | 7.5 |
| <a href="#">FI55205</a> | Corporate Responsibility and Ethics | 7.5 |

### Optional courses:

|                         |   |     |
|-------------------------|---|-----|
| <a href="#">TBA4275</a> | Dynamic Response to Irregular Loadings      | 7.5 |
| <a href="#">TBA5100</a> | Theoretical Soil Mechanics                  | 7.5 |
| <a href="#">TMR4137</a> | Sustainable Utilization of Marine Resources | 7.5 |
| <a href="#">TMR4235</a> | Stochastic Theory of Sea Loads              | 7.5 |

### Recommended extra course:

Norwegian Elementary (NTNU Language Departments' online course)

URL: <https://www.ntnu.edu/now>

### Track 1 courses in semester 2 (TUD)

| Compulsory courses:        |                           |    | quarter   |
|----------------------------|---------------------------|----|-----------|
| <a href="#">CIE4061-09</a> | Multidisciplinary Project | 10 | 2.1 + 2.2 |
| <a href="#">CIE4305</a>    | Coastal Dynamics 1        | 6  | 2.1       |
| <a href="#">OE44115</a>    | Arctic Engineering        | 4  | 2.1       |

### Optional courses:

Recommended:

|                         |                              |   |     |
|-------------------------|------------------------------|---|-----|
| <a href="#">CIE4309</a> | Coastal Dynamics 2           | 5 | 2.2 |
| <a href="#">CIE5308</a> | Breakwaters and Closure Dams | 4 | 2.1 |

Other optional courses:

|                         |   |   |     |
|-------------------------|---|---|-----|
| <a href="#">CIE5312</a> | Turbulence in Hydraulics                  | 3 | 2.1 |
| <a href="#">CIE5314</a> | Flood Defences                            | 3 | 2.2 |
| <a href="#">OE44030</a> | Offshore Geotechnical Engineering         | 4 | 2.1 |
| <a href="#">OE44100</a> | Floating Structures and Offshore Moorings | 6 | 2.2 |
| <a href="#">OE44135</a> | Offshore Wind Support Structures          | 4 | 2.2 |
| <a href="#">OE44120</a> | Offshore Wind Farm Design                 | 4 | 2.1 |

Any other course at TUD shall be approved by the Track 1 Tutor. A formal written request must be sent in advance to the Track Tutor who will administer the approval process.



**Recommended extra course:**

|   |    |         |
|---|----|---------|
| <a href="#">CIE4040-09</a> Traineeship (Internship) | 10 | summer  |
| Dutch Elementary                                    | 3  | 2.1+2.2 |

*Track 1 courses in semester 3 (TUD)***Compulsory courses:**

|   |   |           |
|---|---|-----------|
| <a href="#">CIE4130</a> Probabilistic Design and Risk Management      | 4 | 1.2       |
| <a href="#">CIE4310</a> Bed, Bank and Shore Protection                | 4 | 1.2       |
| <a href="#">CIE4340</a> Computational Modelling of Flow and Transport | 4 | 1.1 + 1.2 |

**Optional courses:**

Recommended:

|  |   |           |
|--|---|-----------|
| <a href="#">CIE4190</a> Analysis of Slender Structures     | 4 | 1.1       |
| <a href="#">CIE4330</a> Ports and Waterways 1              | 4 | 1.1 + 1.2 |
| <a href="#">CIE5318</a> Fieldwork Hydraulic Engineering    | 4 | 1.1       |
| <a href="#">OE44095</a> Bottom Founded Offshore Structures | 6 | 1.2       |

**Conditional optional course<sup>2</sup>**

|  |   |       |
|--|---|-------|
| <a href="#">AT327-12</a> Arctic Offshore Engineering (UNIS in October) | 6 | (1.1) |
|--|---|-------|

Other optional courses:

|  |   |     |
|--|---|-----|
| <a href="#">CIE4115</a> Steel Structures 2                   | 4 | 1.1 |
| <a href="#">CIE4606</a> Geodesy and Remote Sensing           | 5 | 1.1 |
| <a href="#">OE44005</a> Introduction to Offshore Engineering | 3 | 1.1 |
| <a href="#">OE44010</a> Introduction to Dredging Engineering | 3 | 1.1 |

Any other course at TUD shall be approved by the Track 1 Tutor. A formal written request must be sent in advance to the Track 1 Tutor who will administer the approval process.

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<sup>2</sup> The Svalbard courses AT327-12 and AT-307F are included as an option if you plan to specialize in Arctic offshore engineering and do your master's thesis in this field.

Typical topics are:

- Arctic Offshore Field Development
- Ice-structure interaction
- Ice mechanics

You must therefore discuss your thesis topic well in advance with the Track 1 tutor at NTNU before applying. However, you apply under the TUD system.

For all other students in Track 1, you must choose courses among the other courses listed above. In particular, CIE5318 Fieldwork Hydraulic Engineering is highly recommended. The fieldwork of this course usually collides with the AT327-12 course at Svalbard, so both courses are probably not elective.

### *Track 1 course in semester 4 (NTNU)*

#### **Compulsory course:**

[TBA4920](#) MSc Thesis (Arctic Marine Coastal Engineering) 30

#### **Conditional optional extra course (see footnote on previous page)**

[AT-307F](#) Arctic Offshore Engineering (Fieldwork) 3

## **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 you obtained 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 you 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 EC, i.e. at least 30 EC in semester 1 at NTNU, Trondheim, at least 30 EC in semester 2 at UPC, Barcelona and at least 60 EC during semesters 3 and 4 at City, London. Only courses listed below counts.

#### Track 2 courses in semester 1 (NTNU)

| Compulsory courses:     |                                     | EC  |
|-------------------------|-------------------------------------|-----|
| <a href="#">TBA4145</a> | Port and Coastal Facilities         | 7.5 |
| <a href="#">TBA4265</a> | Arctic and Marine Civil Engineering | 7.5 |
| <a href="#">FI55205</a> | Corporate Responsibility and Ethics | 7.5 |

**Optional courses:**

|                         |   |     |
|-------------------------|---|-----|
| <a href="#">TBA4275</a> | Dynamic Response to Irregular Loadings      | 7.5 |
| <a href="#">TBA5100</a> | Theoretical Soil Mechanics                  | 7.5 |
| <a href="#">TMR4137</a> | Sustainable Utilization of Marine Resources | 7.5 |
| <a href="#">TMR4235</a> | Stochastic Theory of Sea Loads              | 7.5 |
| <a href="#">TPK4120</a> | Safety and Reliability Analysis             | 7.5 |

**Recommended extra courses:**

Norwegian Elementary (NTNU Language Departments' online course)

URL: <https://www.ntnu.edu/now>

*Track 2 courses in semester 2 (UPC)* [Link to Course descriptions \(UPC\)](#).**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 extra course:**

|        |  |   |
|--------|--|---|
| 250608 | Meteo-Oceanographic Time Series: Time and Frequency Analyses | 3 |
|--------|--|---|

**Recommended extra course:**

|  |                    |   |
|--|--------------------|---|
|  | Spanish Elementary | 3 |
|--|--------------------|---|

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

|                         |                                   |     |
|-------------------------|-----------------------------------|-----|
| <a href="#">EPM 782</a> | Maritime Operations and Insurance | 7.5 |
| <a href="#">EPM 785</a> | Maritime Economics and Accounting | 7.5 |
| <a href="#">EPM 786</a> | Maritime Management               | 7.5 |

**Optional Courses:**

|                         |                               |      |
|-------------------------|-------------------------------|------|
| <a href="#">EPM 403</a> | Risk Management               | 3.75 |
| <a href="#">EPM 783</a> | Maritime Technology           | 7.5  |
| <a href="#">EPM 784</a> | Maritime Law                  | 7.5  |
| <a href="#">EPM 788</a> | Port Strategy and Development | 3.75 |

|                         |                                     |      |
|-------------------------|-------------------------------------|------|
| <a href="#">EPM 790</a> | Environmental Issues                | 7.5  |
| <a href="#">EPM 791</a> | Marketing of Marine Services        | 3.75 |
| <a href="#">EPM 792</a> | Security Studies                    | 3.75 |
| <a href="#">EPM 794</a> | Offshore Engineering and Operations | 3.75 |

### *Track 2 course in semester 4 (City)*

#### **Compulsory course:**

|         |   |    |
|---------|---|----|
| EPM 402 | Dissertation (Marine Operations and Management) | 30 |
|---------|---|----|

## **Track 3 - Environment and Management (SOTON)**

### **Learning objectives Track 3**

#### **Knowledge**

The Environment and Management track provides you 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 you 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.

## List of Compulsory and Optional Courses of Track 3 – Environment and Management (SOTON)

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 and at least 60 EC in semesters 3 and 4 at SOTON, Southampton. Only courses listed below counts.

*Track 3 courses in semester 1 (NTNU)***Compulsory courses:**

|                         |                                     | EC  |
|-------------------------|-------------------------------------|-----|
| <a href="#">TBA4145</a> | Port and Coastal Facilities         | 7.5 |
| <a href="#">TBA4265</a> | Arctic and Marine Civil Engineering | 7.5 |
| <a href="#">FI55205</a> | Corporate Responsibility and Ethics | 7.5 |

**Optional courses:**

## Recommended:

|                         |   |     |
|-------------------------|---|-----|
| <a href="#">TMR4137</a> | Sustainable Utilization of Marine Resources | 7.5 |
| <a href="#">TPK4120</a> | Safety and Reliability Analysis             | 7.5 |

## Other optional courses:

|                         |  |     |
|-------------------------|--|-----|
| <a href="#">TBA4275</a> | Dynamic Response to Irregular Loadings | 7.5 |
| <a href="#">TBA5100</a> | Theoretical Soil Mechanics             | 7.5 |
| <a href="#">TMR4235</a> | Stochastic Theory of Sea Loads         | 7.5 |

**Recommended extra courses:**

Norwegian Elementary (NTNU Language Departments' online course)

URL: <https://www.ntnu.edu/now>

*Track 3 courses in semester 2 (UPC) [Link to Course descriptions \(· UPC\)](#).***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 |
|--------|--|---|

**Recommended extra course:**

|                    |   |
|--------------------|---|
| Spanish Elementary | 3 |
|--------------------|---|



**Track 3 courses in semester 3 (SOTON)****Compulsory courses for all:**

|                          |                                  |     |
|--------------------------|----------------------------------|-----|
| <a href="#">SOES6074</a> | Contemporary Topics              | 7.5 |
| <a href="#">ENVS6032</a> | Geographical Information Systems | 7.5 |
| <a href="#">ENVS6028</a> | Environmental Impact Assessment  | 7.5 |

**Optional courses**

|                          |   |     |
|--------------------------|---|-----|
| <a href="#">SOES3014</a> | Coastal Sediment Dynamics                   | 7.5 |
| <a href="#">CENV6084</a> | Coastal and Maritime Energy and Engineering | 7.5 |

**Track 3 course in semester 4 (SOTON)****Compulsory course:**

|                          |                      |    |
|--------------------------|----------------------|----|
| <a href="#">FEEG6012</a> | MSc Research Project | 30 |
|--------------------------|----------------------|----|

**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.
- Analyse 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 EC, i.e. at least 30 EC in semester 1 at NTNU, Trondheim, at least 30 EC in semester 2 at TU Delft, at least 30 EC in semester 3 at SOTON, Southampton and 30 EC in semester 4 at TU Delft. Only courses listed below counts.

#### Track 4 courses in semester 1 (Trondheim)

| Compulsory courses:     |                                     | EC  |
|-------------------------|-------------------------------------|-----|
| <a href="#">TBA4145</a> | Port and Coastal Facilities         | 7.5 |
| <a href="#">TBA4265</a> | Arctic and Marine Civil Engineering | 7.5 |
| <a href="#">FI55205</a> | Corporate Responsibility and Ethics | 7.5 |

#### Optional courses:

Recommended:

|                         |   |     |
|-------------------------|---|-----|
| <a href="#">TMR4137</a> | Sustainable Utilization of Marine Resources | 7.5 |
| <a href="#">TPK4120</a> | Safety and Reliability Analysis             | 7.5 |

Other optional courses:

|                         |  |     |
|-------------------------|--|-----|
| <a href="#">TBA4275</a> | Dynamic Response to Irregular Loadings | 7.5 |
| <a href="#">TBA5100</a> | Theoretical Soil Mechanics             | 7.5 |
| <a href="#">TMR4235</a> | Stochastic Theory of Sea Loads         | 7.5 |

#### Recommended extra courses:

Norwegian Elementary (NTNU Language Departments' online course)

URL: <https://www.ntnu.edu/now>

#### Track 4 courses in semester 2 (Delft)

| Compulsory courses for all: |                           |    | quarter   |
|-----------------------------|---------------------------|----|-----------|
| <a href="#">CIE4061-09</a>  | Multidisciplinary Project | 10 | 2.1 + 2.2 |
| <a href="#">CIE4305</a>     | Coastal Dynamics 1        | 6  | 2.1       |

#### Optional courses:

Recommended:

|                         |  |   |           |
|-------------------------|--|---|-----------|
| <a href="#">CIE4130</a> | Probabilistic Design<br>(not if TPK4120 completed in Norway) | 4 | 2.1*      |
| <a href="#">CIE4301</a> | Building with Nature in Hydraulic Engineering                | 5 | 2.2       |
| <a href="#">CIE4309</a> | Coastal Dynamics 2   | 5 | 2.2       |
| <a href="#">CIE4310</a> | Bed, Bank and Shore Protection                               | 4 | 2.1*+2.2* |
| <a href="#">CIE4340</a> | Computational Modelling of Flow and Transport                | 4 | 2.1*      |
| <a href="#">CIE5300</a> | Dredging Technology  | 4 | 2.1       |
| <a href="#">CIE5302</a> | Stratified Flows   | 3 | 2.2       |
| <a href="#">CIE5306</a> | Ports and Waterways 2  | 4 | 2.2       |
| <a href="#">CIE5308</a> | Breakwaters and Closure Dams                                 | 4 | 2.1       |
| <a href="#">CIE5312</a> | Turbulence in Hydraulics                                     | 3 | 2.1       |
| <a href="#">CIE5314</a> | Flood Defences   | 3 | 2.2       |

(\* = videotaped course. Exam at end of designated quarter)

Other optional courses:

|                         |                           |   |     |
|-------------------------|---------------------------|---|-----|
| <a href="#">CIE4460</a> | Polders and Flood Control | 4 | 2.2 |
| <a href="#">CIE5304</a> | Waterpower Engineering    | 3 | 2.2 |

Any other course at TUD shall be approved by the Track 4 Tutor. A formal written request must be sent in advance to the Track 4 Tutor who will administer the approval process.

Recommended extra course:

|                            |                          |    |         |
|----------------------------|--------------------------|----|---------|
| <a href="#">CIE4040-09</a> | Traineeship (Internship) | 10 | summer  |
|                            | Dutch Elementary         | 3  | 2.1+2.2 |

#### *Track 4 courses in semester 3 (Southampton)*

**Compulsory courses for all:**

|                          |                                  |     |
|--------------------------|----------------------------------|-----|
| <a href="#">SOES6074</a> | Contemporary Topics              | 7.5 |
| <a href="#">ENVS6032</a> | Geographical Information Systems | 7.5 |
| <a href="#">ENVS6028</a> | Environmental Impact Assessment  | 7.5 |

**Optional courses**

|                          |   |     |
|--------------------------|---|-----|
| <a href="#">SOES3014</a> | Coastal Sediment Dynamics                   | 7.5 |
| <a href="#">CENV6084</a> | Coastal and Maritime Energy and Engineering | 7.5 |

#### *Track 4 course in semester 4 (Delft)*

|                         |                                  |    |
|-------------------------|----------------------------------|----|
| <a href="#">CIE5030</a> | MSc Thesis (Coastal Engineering) | 30 |
|-------------------------|----------------------------------|----|

## 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 you 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 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:

|                         |                                     |     |
|-------------------------|-------------------------------------|-----|
| <a href="#">TBA4145</a> | Port and Coastal Facilities         | 7.5 |
| <a href="#">TBA4265</a> | Arctic and Marine Civil Engineering | 7.5 |
| <a href="#">FI55205</a> | Corporate Responsibility and Ethics | 7.5 |

##### Optional courses:

###### Recommended:

|                         |   |     |
|-------------------------|---|-----|
| <a href="#">TMR4137</a> | Sustainable Utilization of Marine Resources | 7.5 |
| <a href="#">TPK4120</a> | Safety and Reliability Analysis             | 7.5 |

###### Other optional courses:

|                         |  |     |
|-------------------------|--|-----|
| <a href="#">TBA4275</a> | Dynamic Response to Irregular Loadings | 7.5 |
| <a href="#">TBA5100</a> | Theoretical Soil Mechanics             | 7.5 |
| <a href="#">TMR4235</a> | Stochastic Theory of Sea Loads         | 7.5 |

##### Recommended extra courses:

Norwegian Elementary (NTNU Language Departments' online course)

URL: <https://www.ntnu.edu/now>

#### Track 5 courses in semester 2 (UPC) [Link to Course descriptions \(- UPC\).](#)

##### 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:<br>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:<br>Time and Frequency Analyses | 3 |
|--------|---|---|

**Recommended extra course:**

|  |                    |   |
|--|--------------------|---|
|  | Spanish Elementary | 3 |
|--|--------------------|---|

*Track 5 courses in semester 3 (SOTON)*

**Compulsory courses for all:**

|                          |                                  |     |
|--------------------------|----------------------------------|-----|
| <a href="#">SOES6074</a> | Contemporary Topics              | 7.5 |
| <a href="#">ENVS6032</a> | Geographical Information Systems | 7.5 |
| <a href="#">ENVS6028</a> | Environmental Impact Assessment  | 7.5 |

**Optional courses**

|                          |   |     |
|--------------------------|---|-----|
| <a href="#">SOES3014</a> | Coastal Sediment Dynamics                   | 7.5 |
| <a href="#">CENV6084</a> | Coastal and Maritime Energy and Engineering | 7.5 |

*Track 5 course in semester 4 (UPC)*

**Compulsory course:**

|       |  |    |
|-------|--|----|
| 31606 | MSc Thesis (Engineering and Environment) | 30 |
|-------|--|----|