MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

2025-2026

YEAR 2

MARINE TECHNOLOGY

HYDRODYNAMICS FOR OCEAN ENGINEERING

PROGRAMME SUPERVISOR(S):
Zhe LI

YEAR 2 - Autumn Semester

CORE COURSES

Course code	Title	ECTS Credits
CONF	Conferences	-
PROJT	Project	-
TOME3	Tools and Methods for Research 3	5
WSINT	Wave-structure Interactions and Moorings	4
WWSSM	Water Waves and Sea States Modeling	4

ELECTIVE COURSES

Course code	Title	ECTS Credits
APPROB	Approximation Methods in Computational Mechanics and Probabilistic Methods in Mechanics	5
EXPHY	Experimental Hydrodynamics	5
MONIT	Monitoring Strategy and Monitoring Systems	5
MRENE	Marine Renewable Energy	5
MUQUANT	Metamodelling and Uncertainty Quantification	5
NAVEN	Naval Engineering	5
NUMHY	Numerical Hydrodynamics	5
REMHY	Research in Marine Hydrodynamics	5

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE3	Cultural and Communication English	2
ESP3	Spanish Language	2
FLE3	French Language	2

YEAR 2 - Spring Semester

CORE COURSES

Course code	Title	ECTS Credits
THESIS	Master Thesis or Internship	30

Master Programme - Marine Technology - Hydrodynamics for Ocean Engineering

YEAR 2 - Autumn Semester

Conferences [CONF]

LEAD PROFESSOR(S): Zhe LI

Objectives

This course gathers different conferences organized within the course of the M2 MTECH-HOE (industrial partners, scientific communication, etc.).

The conferences are planned every year and consequently differ from one year to another. They are provided by university scholars, industrial partners, alumni, etc. in order to provide the students a general overview of the field of ocean engineering: challenges, working opportunities, etc.

Course contents

The conferences are planned every year and consequently differ from one year to another. They are provided by university scholars, industrial partners, alumni, etc. in order to provide the students a general overview of the field of ocean engineering: challenges, working opportunities, etc.

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

This lecture series supports sustainability and social responsibility by raising awareness of key challenges (energy transition, environmental impacts, safety, ethics) through industrial and research perspectives. It promotes responsible professional practice: evidence-based decision-making, transparency about limitations, and constructive engagement with stakeholders.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	-	12 hrs	0 hrs	0 hrs	0 hrs	0 hrs

Project [PROJT]

LEAD PROFESSOR(S): Antoine DUCOIN

Objectives

This module contains specific projects carried on during the first semester of the M2 MTECH-HOE.

The projects are proposed each year and consequently differ one year from another.

Course contents

This module contains specific projects carried on during the first semester of the M2 MTECH-HOE.

The projects are proposed each year and consequently differ one year from another.

Sustainable Development Goals (SDGs) covered by this course

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	-	0 hrs	0 hrs	0 hrs	30 hrs	0 hrs

Master Programme - Marine Technology - Hydrodynamics for Ocean Engineering

YEAR 2 - Autumn Semester

Tools and Methods for Research 3 [TOME3]

LEAD PROFESSOR(S): Guillaume DUCROZET

Objectives

Thiscourse aims to apply the knowledge and skills acquired by students during the first year of the Master's programme to a topic directly related to the research activities conducted within the LHEEA laboratory. It enables students to deepen their understanding of current scientific issues, become familiar with laboratory research methods and tools, and further develop their ability to carry out applied research in an autonomous and structured manner.

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

This course incorporates sustainable development considerations into the selection of student projects. These projects demonstrate varying degrees of connection to this theme, depending on the opportunities available at the time the projects are undertaken.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	null hrs	null hrs	null hrs	32 hrs	null hrs

Wave-structure Interactions and Moorings [WSINT]

LEAD PROFESSOR(S): Vincent LEROY

Requirements

Mathematics
Fluid Mechanics
Water Waves and Sea-States Modelling

Objectives

The objective of the first part of the course is to give a complete presentation of the available models for the determination of marine structure response in a seaway, emphasizing the advantages and drawbacks of each approach. A complete presentation of the linearized theory of wave-body interactions, treated in a deterministic sense, is first given. Both frequency domain and time domain approaches are described. Fundamental relations between both solutions are systematically emphasized. High and low frequency second order effects are explained and illustrated. Then, an overview of the available nonlinear theories and numerical models for wavestructure interactions is given. Different levels of approximation are described, from the simple addition of nonlinear hydrostatics to fully nonlinear time domain models.

The second part addresses the modelling of mooring systems. Different options in terms of mooring systems and arrangements are presented in order to give students the main information necessary for undertaking a mooring design process.

For both parts, lectures are completed by practical exercises based on state-of-the-art software for wave-structure interaction and mooring modeling, using both frequency domain and time-domain analysis. The topics of the practical sessions will be realistic ocean engineering problems such as the response of a floating wind turbine platform to waves, for example.

Course contents

Lesson 1 - Objectives, theoretical framework

Lesson 2 - Short review of linear systems theory

Lesson 3 - Formulation of the boundary value problem. Linearization

Lesson 4 - Frequency domain approach
- Definition of diffraction and radiation sub-problems
- Hydrodynamic loads: added mass and damping
- Calculation of motions
- Relations between elementary solutions

5 - Time domain approach
- Forced motion of a floating body
- Formulation of the diffraction problem in the time domain
- Equations of motion
- Relation to frequency domain response

Lesson 6 - Second-order effects and introduction to non-linear models
- Drift forces
- Low and high-frequency loading in irregular waves
- Nonlinear hydrostatics and Froude-Krylov loading
- Weak scattered hypothesis

▪ Fully nonlinear models

Lesson 7 & 8 - Moorings for marine structure
▪ Some examples in Oil and Gas energy
▪ Different types of mooring systems
▪ Offloading operations

▪ Some examples in Marine Renewable energy
▪ Mooring main functions
▪ Mooring arrangement
▪ Mooring components
▪ Environmental conditions
▪ Mooring Design basis

Course material

▪ Molin, B. (2023). Offshore structure hydrodynamics. Cambridge University Press.
▪ J.N. Newman (1977). Marine Hydrodynamics. MIT Press.
▪ O.M. Faltinsen (1990). Sea Loads on Ships and Offshore Structures. Cambridge University Press.
▪ Adrian Biran (2003). Ship Hydrostatics and Stability. Butterworth-Heinemann.
▪ API recommended Practice 2SK (2005). Design and analysis of Station-keeping Systems for Floating Structures.
▪ Vryhof anchors (2010) Anchor Manual. The Guide to Anchoring.

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Wave-structure interaction modeling and mooring enable the development of offshore renewable energies.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	18 hrs	2 hrs	10 hrs	0 hrs	2 hrs

Water Waves and Sea States Modeling [WWSSM]

LEAD PROFESSOR(S): Guillaume DUCROZET

Requirements

Master1 - Fluid Mechanics 1
Master1 - Fluid Mechanics 2
Master1 - Marine Hydrodynamics 1
Master1 - Marine Hydrodynamics 2
Master 1 - Algorithmics for Engineering Modeling

Objectives

This course provides an overview of some of the numerous mathematical models used to represent free-surface gravity waves and the associated underlying flow. The models are used to describe the main physical features of ocean wave propagation. The scope is voluntarily restricted to the most useful models generally used by ocean/marine engineers and researchers. In a few cases, a deeper theoretical insight is presented in order to allow the students to understand the subtleties of water wave theory and nonlinear physics. In the second part, the use of the statistical approach is presented, both for the representation of sea states and sea structures' responses.

After completing the course, students will be able to:
- Identify the wave theory adequate to model a given regular wave.
- Describe in detail the physics of dispersive waves.
- Develop or use numerical models for the wave propagation.
- Interpret and use Metocean data in the context of ocean engineering.

Course contents

Lesson 1 - Introduction to marine environment
Description of the ocean and the different kind of waves. Focus on gravity waves and the processes responsible for their generation.

Lesson 2 - Gravity wave modelling
Derivation of the governing non-linear equations and introduction of the multiple scale method to generate a particular subset of equations

Lesson 3&4 - Dispersive waves
- Airy Potential; derivation of the solution by separation of variables. Expression of all the related physical quantities: group velocity, energy density, energy flux, limits of the linear model.
- Higher order Stokes solutions (3rd order, 5th order). Sequential construction of the Stokes higher order solutions. Specific nonlinear features of Stokes waves.
- Wave refraction and shoaling in coastal regions.

Lesson 5 – Shallow water (non-dispersive) waves
Derivation of the governing equations and analytical solutions to the problem: solitons and cnoidal waves.

Lesson 6 - Statistical models for wave field description
- Random sea state modeling.
- Usual wave spectra models.
- Wave generation.

Lesson 7 - Random responses of structures at sea
- Random responses of a linear system.

- Review of the results for ship responses by a deterministic theory.
- Motion on a real sea state.
- Extreme responses, and design factors.

Course material

▪ Robert G. Dean & Robert A. Dalrymple, Water wave mechanics for engineers and scientists, Advanced Series on Ocean Engineering (vol.2).
▪ A.J. Hermans, Water waves and ship hydrodynamics: an introduction.
▪ C.C. Mei, M. Stiassnie & D.K.P. Yue, Theory and application of ocean surface waves, Advanced Series on Ocean Engineering (vol.23). Part I: Linear aspects; Part II: Non-linear aspects

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

The Water Waves and Sea State Modelling course incorporates sustainable development considerations, notably through the application examples presented in the lectures and the topics addressed during tutorial sessions. Owing to its disciplinary nature, the knowledge and skills acquired may be applied across a wide range of fields related to sustainable development.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	14 hrs	4 hrs	12 hrs	0 hrs	2 hrs

Approximation Methods in Computational Mechanics and Probabilistic Methods in Mechanics [APPROB]

LEAD PROFESSOR(S): Mathilde CHEVREUIL

Sustainable Development Goals (SDGs) covered by this course

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	20 hrs	20 hrs	6 hrs	0 hrs	2 hrs

Experimental Hydrodynamics [EXPHY]

LEAD PROFESSOR(S): Félicien BONNEFOY

Sustainable Development Goals (SDGs) covered by this course

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	12 hrs	0 hrs	20 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Hydrodynamics for Ocean Engineering

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Monitoring Strategy and Monitoring Systems [MONIT]

LEAD PROFESSOR(S): Franck SCHOEFS

Sustainable Development Goals (SDGs) covered by this course

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	8 hrs	8 hrs	0 hrs	2 hrs

Marine Renewable Energy [MRENE]

LEAD PROFESSOR(S): Sandrine AUBRUN

Requirements

Fluid mechanics, free-surface hydrodynamics

Objectives

To provide students with (i) a good understanding of the fundamentals of wind turbines, tidal turbines and wave energy converter performance and (ii) a first experience with the assessment of the performance of these technologies.

Course contents

Part 1 - Fundamentals of turbine performance. This course is an introduction to the "offshore wind turbines" and "current turbine" classes. The objective is to understand the fundamentals of turbine performance, with a focus on marine applications. We will focus on the main operating principle of turbines, followed by the understanding of flow physics and performance of turbine blades operating in the marine environment. The performances of turbine blades and rotor will be seen through the BEMT (Blade Element Momentum Theory).

Part 2 - Current turbines. This part of the course will describe, the resource, market and advanced technologies of current turbines. Experimental and numerical methods for studying current turbines will be outlined. An overview of current activities in the field of current turbines will be given. Numerical exercises will aim to calculate the performance of a current turbine in different operating conditions.

Part 3 - Offshore wind turbines. Firstly, this part of the course will provide general figures on the installed wind power capacity in the world and in Europe. Then, the components of a wind turbine will be detailed and the general operation principles will be described. Rotor technologies, drive-train and generators, as well as bottom fixed and floating foundations will be addressed, as well as strategies for coupled numerical modelling of such systems. Park effects will be also outlined. Numerical exercises will be carried out in order to investigate the wind turbine aerodynamics, the park effects and to introduce to the challenges linked to the design of floating offshore wind turbines.

Part 4 - Wave energy converters. The objective of this part of the course is (i) to give to the student a good understanding of the current status of wave energy conversion technologies in terms of potential and actual performance. Thus, it will address first the wave energy resource and market. A historical perspective of wave energy conversion will be given and an overview of the technology will be described. Fundamentals of wave energy conversion and energy performance will be highlighted. The energy performance of current technologies will be discussed as well as project development methodologies.

Course material

J. Falnes (2002) Ocean Waves and Oscillating Systems: Linear Interactions Including Wave-Energy Extraction. Cambridge University Press.
J. Cruz (2008) Ocean Wave Energy: Current Status and Future Perspectives. Springer.
B. Multon (2011) Marine Renewable Energy Handbook. Wiley.
J.J. Newman; Marine Hydrodynamics, MIT press, 1977.
I.H. Abbott, A.E.Von Doenhoff, Theory of wing section, Courier Corporation, 1959
J.F. Manwell, J.G. MCGowan & A.L. Rogers (2009) Wind energy explained - Theory, Design and Application. Wiley.
M. C. Brower (2012) Wind resource assessment - A practical guide to developing a wind project. Wiley.

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Industry, innovation and infrastructure / Responsible consumption and production

Sustainable Development and Social Responsibility Positioning

This course is entirely devoted to marine renewable energies, which are part of carbon-free energies. They are intended to contribute to reducing greenhouse gas emissions in the energy sector by exploiting locally available renewable energy sources. All lectures, tutorials and practical sessions of this course deal with sustainable development.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	14 hrs	0 hrs	16 hrs	0 hrs	2 hrs

Metamodelling and Uncertainty Quantification [MUQUANT]

LEAD PROFESSOR(S):

Sustainable Development Goals (SDGs) covered by this course

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	0 hrs	16 hrs	0 hrs	2 hrs

Naval Engineering [NAVEN]

LEAD PROFESSOR(S): Zhe LI

Objectives

This course is divided into three main parts which are all oriented towards fundamental knowledge about ship design. The students learn about ship manoeuvrability, optimization for naval architects and ship designers and application of Computational Fluid Dynamics (CFD) to ship simulation.
Theses topics are direct applications of the concepts introduced in the previous courses.

- Manoeuvrability :
the students learn how to use the mathematical formulation and the analytical resolution of the linearized problem in simple examples such as turning circles. Realistic configurations are then studied by means of numerical simulations of the nonlinear problem.

- Optimization for naval architects and ship designers :
In optimization, the multi-objective approach is used through various examples in naval applications. Different algorithms are presented (gradient, genetic etc) and the Mode-Frontier software is applied to optimize the bulb of a ship in order to minimize the wave resistance.

- Application of CFD tools to ship simulation :
In CFD, the knowledge covered in the Numerical hydrodynamics course is applied to the simulation of a ship with forward speed.

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

This course supports sustainability and social responsibility by combining manoeuvrability analysis, multi-objective optimisation, and viscous-flow CFD to reduce energy demand and emissions (through lower resistance and required propulsive power). The use of numerical tools decreases reliance on physical prototypes and extensive testing, lowering the material and energy footprint of ship design, while improving safety (manoeuvring and nonlinear scenarios) and overall reliability.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	8 hrs	4 hrs	18 hrs	0 hrs	2 hrs

Numerical Hydrodynamics [NUMHY]

LEAD PROFESSOR(S): Lionel GENTAZ

Requirements

MARHY1 & MARHY2 (GP1 M-TECH OE)

Objectives

The goal of this class is to provide students with an overview of Computational Fluid Dynamics (CFD) methods and the simulation environment for the computation of free-surface unsteady flows in Ocean Engineering. Different methods rely on different physical approximations of the fluide-structure (especially wave-structure) interaction problem. According to the approximations made, different numerical methods can be developed and applied.

The primary objective is that students gain a clear vision of the use of different approximations and methods, and of their respective ranges of application, computational cost, human and resource cost of use, versatility, limitations, ease of use, space discretization (mesh), etc... The methods reviewed range from potential flow theory (BEM: Boundary Element Method) to a full description of the Navier-Stokes equations (FV: Finite Volumes) associated with interface models (VoF: Volume of Fluid, LS: Level Set).

For each method, the mathematical model, discretization and implementation principles are explained. Turbulence modeling principles (RANS: Reynolds Averaged Navier-Stokes, LES: Large-Eddy Simulation, hybrid RANS/LES) are provided. The link with space discretization (structured surface meshes, unstructured volume meshes) is detailed. Numerical properties such as convergence, stability, consistency are reviewed.

Finally an introduction to the multi-objectives optimisation is proposed.

Lab works using Navier-Stokes software based on FV numerical methods are proposed to students with the use of a commercial software.

Course contents

Numerical method for potential flow solvers
- Introduction of Boundary Element Methods (BEM), Integral methods solving, Hydrodynamic loading calculation

Numerical methods for viscous flows
- Volume discretization methods (Finite Volumes), time integration, numerical stability, boundary conditions, order of numerical accuracy, etc.

Introduction to multi-objective optimization
- Presentation of the problem of optimization in engineering
- Presentation of typical optimization methods: simplex method, gradient-based method and genetic methods
- The students learn to write a simple program for carrying out an optimization task minimizing a cost-function

Navier-Stokes equations solution techniques
- State of the art of CFD in hydrodynamics for Ocean Engineering
- Pressure-velocity coupling, Linear system solving
- Hydrodynamic loading calculation, Interface methods (VoF, LS)
- Introduction to turbulence modeling and Turbulence models (RANS, LES)
- Lab work is dedicated to use of a CFD Viscous flow solver for academic cases (lid-driven cavity, turbulent flow over a step ...)

Course material

- H. Lomax et al., Fundamentals of Computational Fluid Dynamics, Springer, 2011
- B. Andersson et al., Computational Fluid Dynamics for engineers, Cambridge Univ. Press, 2011
- J.H. Ferziger, M. Peric, Computational Methods for Fluid Dynamics, Springer, 1997
- J.F. Wendt, Computational Fluid Dynamics, an introduction, Springer, 2009
- R.H. Nichols, Turbulence Models and Their Application to Complex Flows, Univ. Alabama, 2012
- V. Bertram, Practical Ship Hydrodynamics, Elsevier, 2012

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Numerical methods are a way to study and optimize the behavior and performance of ocean structures at sea in order to reduce their impact on the environment or their energy needs. Optimization processes (for example reduction of the drag using a bulbous bow in the problem of ship resistance) are using hydrodynamic solvers based on the numerical methods presented in this course.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	4 hrs	10 hrs	0 hrs	2 hrs

Research in Marine Hydrodynamics [REMHY]

LEAD PROFESSOR(S): Antoine DUCOIN

Objectives

To provide students an overview of the current research in numerical methods for hydrodynamics.

Course contents

Lesson 1 - LBM (lattice Boltzmann method)
Over the last two decades, the lattice Boltzmann method (LBM) has emerged as a promising numerical tool for simulating, and not limited to, various types of fluid flows in nature as well as in engineering applications. It has been recently demonstrated that the LBM can be systematically derived from the Boltzmann equation (kinetic theory). This inherent feature allows the LBM to solve fluid dynamic problems with a large range of scales. This course consists of four hours of lectures and four hours of programming lab work. The theoretical basis of the LBM is first presented in the lecture, such as the derivation from the Boltzmann equation using Hermite polynomial expansion, the relation with the Navier-Stokes equation via the Chapman-Enskog analysis. The second part of the lecture is devoted to the presentation of the numerical aspects of the LBM, such as the collision and streaming steps, the boundary condition treatment. In the lab
work, the students will learn how to write an LBM program using Matlab in order to simulate some academic test-cases, e.g. Poiseuille flow, lid driven cavity. The objective of the lab work is to make the students better understand this numerical method and experience its simplicity of implementation.

Lesson 2 - FSI (Fluid Structure Interaction)
An overview of Fluid Structure Interactions (FSI) for hydrodynamic applications is presented in this class. The first part concerns the basic equations for fluid structure interaction problems, followed by a non-dimensional analysis to extract the different class of fluid structure interactions. The class will then focus on the particular case of flow induced vibration. Two simple FSI problems are then studied: the free motion of a 2D cylinder under unsteady, periodic flow, and the static deformation of a 2D hydrofoil under stationary flow. In the third part, an overview of the numerical methods for fluid structure interaction problems is presented. In the computer lab work, students will study a free oscillating cylinder submitted to hydrodynamic flow, using Direct Numerical Simulation (DNS).

Lesson 3 - SPH (Smoothed Particle Hydrodynamics)
The Smoothed Particle Hydrodynamics method is of growing interest for complex free surface flows, mainly when characteristic times are short (impact, slamming, sloshing, spray, etc.). The course covers the various aspects of the method theory and application to marine engineering. First are highlighted the different reasons why this method is well suited to these complex free surface problems (advantages), and why it is also mainly limited to them (drawbacks). The method theory is then developed and compared to standard mesh-based methods in terms of: schemes of approximation of the differential operators, convergence and accuracy, explicit solving of Navier-Stokes equations, weak-compressibility assumption, quasi-Lagrangian description, etc. Implementation is also discussed, especially in the context of High Performance Computing. Finally, it is shown how this method is applied to industrial marine engineering problems, and it is discussed what are its current trends of development: improvement of convergence, particle refinement, easy Fluid-Structure Interaction, coupling to Finite Volumes.

Course material

Lecture 1 (LBM):
▪ Shan, X., Yuan, X.F., Chen, H. Kinetic theory representation of hydrodynamics: a way beyond the Navier-Stokes equation. Journal of Fluid Mechanics 550: 413-441, 2006.
▪ Guo, Z., Zheng, C., Shi, B. Discrete lattice effects on the forcing term in the lattice Boltzmann method. Physical Review E 65:

046308, 2002.
▪ Succi, S. The lattice Boltzmann equation: for fluid dynamics and beyond. Oxford University Press. 2001

Lecture 2 (FSI)
▪ M.P. Païdoussis. Fluid-Structure Interaction: Slender Structures and Axial Flow. Academic Press, 2004
▪ J.F. Sigrist, Fluid-Structure Interaction: An Introduction to Finite Element Coupling, Wiley, 2015

Lecture 3 (SPH):
▪ D. Le Touzé, 'Smoothed Particle Hydrodynamics, fact checking: from theory to applications', Keynote lecture at the 2017 SPHERIC international workshop, http://spheric-sph.org//files/SPHERIC_Beijing_Keynote_pdf.pdf
▪ G.R. Liu, M.B. Liu, 'Smoothed Particle Hydrodynamics, a meshfree particle method', World Scientific Pub Co Inc

Sustainable Development Goals (SDGs) covered by this course

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	12 hrs	0 hrs	18 hrs	0 hrs	2 hrs

Cultural and Communication English [CCE3]

LEAD PROFESSOR(S): David TROYA

Objectives

- Understand the fundamental principles of scientific writing and the importance of clarity and precision in communication.
- Structure scientific documents effectively, adhering to genre-specific conventions.
- Employ appropriate language and tone for diverse scientific audiences.
- Integrate and cite sources correctly to support research arguments and findings.
- Edit and revise their writing for coherence, style, and grammatical accuracy.
- Prepare and deliver scientific presentations, both written and oral.

Course contents

Introduction to Scientific Writing

Overview:

This course provides an essential foundation in scientific writing, equipping students with the skills necessary to effectively communicate research findings and scientific concepts. Through a combination of lectures, workshops, and practical assignments, students will learn the conventions of scientific writing, including structure, style, and clarity. The course will cover various types of scientific documents, such as research papers, literature reviews, grant proposals, and poster presentations.

Course Structure:

The course will be organized into weekly sessions that include lectures on theoretical concepts, hands-on writing exercises, peer review workshops, and discussions of exemplary scientific literature. Students will engage in collaborative projects and receive constructive feedback to enhance their writing skills.

Assessment:

Students will be assessed through a combination of assignments, including written documents, peer review participation, and presentations. Active participation in workshops and discussions is also required to foster a collaborative learning environment.

Course material

Hoogenboom BJ, Manske RC. How to write a scientific article. Int J Sports Phys Ther. 2012 Oct;7(5):512-7. PMID: 23091783; PMCID: PMC3474301.

Paré G, Kitsiou S. Chapter 9Methods for Literature Reviews. In: Lau F, Kuziemsky C, editors. Handbook of eHealth Evaluation: An Evidence-based Approach [Internet]. Victoria (BC): University of Victoria; 2017 Feb 27. Available from: https://www.ncbi.nlm.nih.gov/books/NBK481583/

How to Create a Research Poster. A guide fo creating a research poster. https://guides.nyu.edu/posters

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Quality education

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Spanish Language [ESP3]

LEAD PROFESSOR(S): Marta HERRERA

Requirements

N/A

Objectives

For beginners:
Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)
Acquisition of vocabulary and linguistic structures
Be able to talk about yourself and those around you
Be able to express oneself during daily activities
Know how to give your opinion

For advanced students:
Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)
Acquisition of specialised vocabulary
Be able to understand the essential content of concrete or abstract subjects including a technical discussion
Be able to communicate spontaneously and fluently
Be able to express oneself in a clear and detailed manner, to express an opinion on a topical subject

Course contents

For beginners:
Personal environment (introduce yourself, express yourself, your tastes, your character, your hobbies, etc.), your surroundings (friends, family, location, climate), your interests (sports, leisure)
Present tense (regular and irregular)
Language patterns to express habit, obligation, "gustar" and its equivalents,
Possessive adjectives
Differences between "es", "está", "hay"
Use of "por" and "para"
Adverbs and frequency patterns
Numeral adjectives

For advanced students:
Knowledge of the Hispanic world (economic, technical, cultural and social environment)
Present tense (regular and irregular)
Imperative
Past tenses
Direct / indirect style
Future tense
Conditional tense
Present and past subjunctive moods

Course material

Preparation manuals, our own tailor-made documents, written and internet press, general civilization documents, digital tools

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Decent work and economic growth / Gender equality / Goo health and well-being / Industry, innovation and infrastructure / No poverty / Partnership s for the goals / Peace, justice and strong institutions / Quality education / Reduced inequalities / Responsible consumption and production / Sustainable cities and communities / Zero hunger

Sustainable Development and Social Responsibility Positioning

Key competencies for sustainability Collaboration: the abilities to learn, to understand and respect others; to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving. Critical thinking: the ability to reflect on one's own values, perceptions and actions. Self-awareness: the ability to reflect on one's own role in a group; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
Spanish	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

French Language [FLE3]

LEAD PROFESSOR(S): Silvia ERTL

Requirements

N/A

Objectives

The objective is to familiarize the learner with the French language and French culture through an entertaining task-based communicative language teaching, focused on speaking combined with:
▪ Phonetics
▪ Self-correcting exercises on our learning platform
▪ Learning Lab activities
▪ Project work
▪ Tutoring

Course objectives include the acquisition and reinforcement of vocabulary, syntax, and pronunciation by both traditional means and through the use of digital resources. Students will learn general French, develop language skills of oral and written comprehension and expression.

After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture.

At the end of the course, complete beginners can achieve an A1
level and some aspects of the A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels. Those who already completed the first year of the French course will be prepared for working in a French business environment.

Course contents

Two different tracks are proposed: track 1 for students newly arrived at Centrale Nantes and track 2 for students who have completed the first year of the French course. Track 1:
Full range of practical communication language exercises: reading comprehension, listening comprehension, written expression, oral expression.
Learners will be able to use the foreign language in a simple way for the following purposes:

1. Giving and obtaining factual information:
▪ personal information (e.g. name, address, place of origin, date of birth, education, occupation)
▪ non-personal information (e.g. about places and how to get there, time of day, various facilities and services, rules and regulations, opening hours, where and what to eat, etc.)

2. Establishing and maintaining social and professional contacts, particularly:
▪ meeting people and making acquaintances
▪ extending invitations and reacting to being invited
▪ proposing/arranging a course of action
▪ exchanging information, views, feelings, wishes, concerning matters of common interest, particularly those relating to personal life and circumstances, living conditions and environment, educational/occupational activities and interests, leisure activities and social life

3. Carrying out certain transactions:

- making arrangements (planning, tickets, reservations, etc.) for travel, accommodation, appointments, leisure activities
- making purchases
- ordering food and drink

Track 2:
This track follows on directly from the first-year French course, developing and completing the concepts studied thus far. The main themes are: housing, health and work. These topics will help prepare students for their future work environment. For example, housing is explored in the form of a search for accommodation upon arrival in a new city. Special workshops for CVs and cover letters, elevator pitches and job interviews.

Course material

Preparation manuals, our own tailor-made documents, written and televised press, internet, general civilization documents, digital tools, our own educational materials on Hippocampus (Moodle).

Sustainable Development Goals (SDGs) covered by this course

Quality education

Sustainable Development and Social Responsibility Positioning

Targeted competencies extracted from: Education for sustainable development goals, learning objectives (UNESCO) https://unesdoc.unesco.org/ark:/48223/pf0000247507 https://www.coe.int/fr/web/common-european-framework-reference-languages/official-translations-of-the-cefr-global-scale

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Master Thesis or Internship [THESIS]

LEAD PROFESSOR(S): Zhe LI

Objectives

- Be exposed to and adapt to an industrial or research environment
- Put in practice the scientific and technical skills acquired in the previous semesters
- Strengthen interpersonal and communication skills
- Be part of or manage a project
- Organize tasks, analyze results and build deliverables

Course contents

Students should be pro-active and career-oriented in the search for their thesis/internship. The topics are validated by the program supervisor to ensure an adequate Master level. The thesis/internship is evaluated through the submission of a written report and an oral defense.

Course material

- Turabian Kate Larimore, Booth Wayne Clayton, Colomb Gregory G., Williams Joseph M., & University of Chicago press. (2013). A manual for writers of research papers, theses, and dissertations: Chicago style for students and researchers (8th edition.). Chicago (Ill.) London: University of Chicago Press.
- Bui Yvonne N. How to Write a Master's Thesis. 2nd ed. Thousand Oaks, Calif: Sage, 2014.
- Evans David G., Gruba Paul, et Zobel Justin. How to Write a Better Thesis. 3rd edition. Carlton South, Vic: Melbourne University Press, 2011.

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

The master’s thesis supports social responsibility and sustainability by preparing students to contribute to impact-driven industrial or research projects through scientific rigor, high-quality deliverables, ethics and integrity (traceability, reproducibility), and responsible teamwork. It also promotes more sustainable engineering choices by encouraging critical analysis of results, optimisation of technical decisions, and clear communication of uncertainties, limitations, and risks.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	30	0 hrs	0 hrs	0 hrs	0 hrs	0 hrs