CENTRALE NANTES

ENGINEERING PROGRAMME

2025-2026

Year 2 / Year 3

Specialisation option

Engineering Science for Housing and Urban Environment

OD PHYCITE

PROGRAMME SUPERVISOR

Isabelle CALMET

Autumn Semester

Course unit	ECTS Credits	Track	Course code	Title
UE 73	12	Core course	CONSTR IBIM PRUES SINBAD	Building engineering BIM initiation Urban issues, ecologies and societies Geographic information systems and databases
UE 74	13	Core course	ATMU CCTAIR ESMU P1PHYCITE THBATP	Urban atmosphere Heating, conditionning and air treatment Water and soil in urban environment Project 1 Thermal performance of buildings

Spring Semester

Course unit	ECTS Credits	Track	Course code	Title
UE 83	14	Core course	ACARE ATRAN ENEVI P2PHYCITE TECBA	Architectural and environmental acoustics Urban planning and transportation Energy at the city scale project 2 Building technology

Building engineering [CONSTR]

LEAD PROFESSOR(S): Patrice CARTRAUD

Objectives

This course is devoted to structural and soil mechanics, and foundations. The basics of these domains are taught under the form of lectures and tutorials focusing on very practical considerations.

Course contents

- The stakeholders and structure professions within construction.
- Eurocode standards
- Structural mechanics : beams
- Basics of reinforced concrete beams
- Basics of soil mechanics : characterisation, stresses, soil hydraulic, shear strength

Course material

- Précis de Structures de Génie Civil, Projets, Dimensionnements, Normalisation D. Didier et al., Afnor, Nathan
- Les Eurocodes : Conception des bâtiments et des ouvrages de Génie Civil
Sous la Direction de Moreau de Saint-Martin et Jean-Armand Calgaro
Edition le Moniteur, ISBN 2-281-12560-8
- Mécanique des Structures, Étude des Poutres, P. Cartraud, 2011, https://cel.archives-ouvertes.fr/cel-00451733/fr/
- Introduction au béton armé: théorie et applications courantes selon l'Eurocode 2., Granju, J. L. 2014, Éditions Eyrolles.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
  - C2C2 : Solve and arbitrate
    - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Quality education

Sustainable Development and Social Responsibility Positioning

This course aims in particular to provide students with the skills to design reinforced concrete structures effectively, thereby contributing to more sustainable design.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	20 hrs	10 hrs	0 hrs	0 hrs	2 hrs

BIM initiation [IBIM]

LEAD PROFESSOR(S): Isabelle CALMET

Objectives

This course deals with the concept of Building Information Modelling (BIM), the actors of BIM, BIM implementation in a project and its application in architectural projects, in connection with building trades. The course is based in particular on the learning of 3D parametric modelling software (REVIT) that incorporates BIM concepts. Approached from the perspective of architectural project production, the course will provide an understanding of modelling methods and structural and constructive design, as well as how to document the project and data for the management and operation of the building.

Course contents

- Concept of Building Information Modelling
- Collaboration methods and definition of a BIM process (BIM specifications, BIM agreements, roles definition)
- Basics in the use of a 3D parametric tool :
  - Modelling a project based on plan analyses
  - Production of representation views (plans, sections, elevations, axonometry)
- Presentation of a BIM project concept : visualization environment
- Architectural and structural design :
  - Management of the 3D database of parametric objects (metric, quantitative)
  - 3D organisation of the model: Files management, compliance with standards, consistency of the model, relevance of the construction method.
- Model geo-localisation, classification and generation of IFC files
- Analysis of an IFC file:
  - Generation of a clash report
  - Information exchanges (BCF files)
  - Data extraction

Course material

Guézo J. et Navarra P. (2018) Revit pour les architectes : Bonnes pratiques BIM, 516 pages, Editions Eyrolles.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
  - C2C2 : Solve and arbitrate
    - Intermediate
  - C2C3 : Think and act in an unpredictable and uncertain environments
    - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

This course trains students in best practices for data management when designing a building project and raises their awareness of the different uses of building information modelling (BIM) throughout a building's life cycle, including the design, construction, operation, renovation and demolition phases. This course therefore addresses the concepts of sustainable construction through the use of BIM.

Assessment

Collective assessment: EVC 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	20 hrs	12 hrs	0 hrs	0 hrs	0 hrs

Urban issues, ecologies and societies [PRUES]

LEAD PROFESSOR(S): Géraldine MOLINA / Isabelle CALMET

Objectives

The first part of the course aims to introduce various notions and concepts necessary for understanding the complexity of the city, to explain what has led to the development of the contemporary city, highlighting the issues of adaptation and response to physical and climatic phenomena in the urban environment, and to present the role of urban engineering and the current solutions adopted in urban planning projects to address the challenges of sustainable urban development.
The second part of the course offers an introduction to the major urban issues facing contemporary societies (social, climate, and environmental justice issues). In order to develop an applied perspective (engineering, architecture, urban planning, public policy) and solutions suitable for today's major socio-technical and ecological challenges, it approaches these issues from an interdisciplinary perspective. It addresses the challenge of building a foundation of theoretical and conceptual knowledge, as well as complementary tools and methods, by drawing on approaches from different disciplinary fields such as the natural sciences and social sciences (urban sociology, social geography).

Course contents

Part One
▪ History of the city - This sequence examines the conditions that shaped cities in the 20th century by exploring the intersection between public policy and architectural and urban theories: from technosolutionism to culturalist approaches, studying the genealogy of plans and ideas reveals numerous parallels with contemporary issues. The main topics covered are as follows:
- Urban planning: early theories and practices
- The Modern Movement: the optimism of a clean slate
- From Reconstruction to large housing estates: architecture as public policy
- The city in the face of crisis: from megastructures to the return of history

▪ Urban Engineering - The topics covered are as follows:
- Reminder of the importance of engineers in cities and the role of networks
- The definition of urban engineering and service issues
- The advent of sustainable development and changing concepts
- New challenges: circularity, resilience, climate issues
- Examples of urban projects, particularly in Paris
- Urban engineering and informality

▪ Urban planning - The course offers a historical and contemporary perspective on how climate and environmental issues are taken into account in urban development. The main topics covered are as follows:
- Regulatory and operational urban planning
- The evolution of thermal and environmental regulations and the role of environmental standards and certifications
- The narratives used in urban development projects

The course concludes with a commented visit of urban projects on the île de Nantes.

Part Two
▪ The courses focus on the relationships between society, health, climate, and ecology by addressing the following questions: How do climate issues (UHI, heatwaves, etc.) concretely affect city inhabitants in their daily lives? How do they cope differently with the same heatwave depending on their socioeconomic profile, standard of living, housing characteristics, and use of space? How can we develop a systemic approach (relationships between human health, the health of living organisms, and the health of ecosystems) through a health-based perspective (eco-health, One Health) and by raising issues at different scales: building, neighborhood, city? The example of nature-based solutions for preserving human and ecosystems health will be discussed in particular.

▪ The tutorials aim to develop applied approaches from engineering, architecture, and urban planning in response to contemporary social, ecological, and climate challenges in order to: (1) take into account the diversity of the different social needs of an urban population and integrate the systemic nature of the current ecological crisis; (2) integrate the results of recent research to design housing, public spaces, and public policies suited to the differentiated needs of populations.
▪ A field visit to Nantes is organised to discover the spaces and stakeholders of a city in transition, and to meet urban professionals involved in implementing concrete solutions in bioclimatic architecture and urban planning, and climate and environmental public policies.

Course material

- Molina, Lefranc, Musy, 2018, Les professionnels du bâtiment face aux défis énergétiques et environnementaux, Compétences et pratiques en transition, ISTE.
- Molina, Hureau, Lamberts, 2023, Les citadins face aux fortes chaleurs : vulnérabilités, vécus habitants, santé et adaptations, https://hal-lara.archives-ouvertes.fr/hal-04172893/
- Bornarel Alain, Marie Héloïse, Lapray Karine, Akiki Edith, 2026, Guide de la nouvelle architecture bioclimatique, Le Moniteur
- Philippe Madec, 2021, Mieux avec moins, Architecture et frugalité pour la paix, Terre urbaine
- Collectif, 2009, Habiter écologique: Quelles architectures pour une ville durable ?, Actes Sud
- Dominique Gauzin-Müller, 2018, Architecture en terre d'aujourd'hui, MUSEO

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Proficient
  - C2C2 : Solve and arbitrate
    - Intermediate
    - Proficient

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Climate action / Goo health and well-being / Reduced inequalities / Responsible consumption and production / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

This course addresses issues of sustainable development and social responsibility through the concepts of sustainable urban development and the systemic integration of social, environmental, and health dimensions into urban planning projects.

Assessment

Collective assessment: EVC 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	24 hrs	8 hrs	0 hrs	0 hrs	0 hrs

Geographic information systems and databases [SINBAD]

LEAD PROFESSOR(S): Jean-Yves MARTIN

Objectives

To introduce the main elements for understanding databases, especially spatial databases which are used in Geographic Information Systems (GIS).

Course contents

This course is divided into 2 parts: theoretical and practical work.

The theoretical aspects include:
- Introduction to functional analysis
- The relational model theory
- From functional analysis to physical models
- Introduction to SQL
- Programming with databases
- Introduction to PL/SQL
- GIS and spatial databases
- Introduction to XML. Main data formats
- Introduction to Spatial Data Infrastructure
- Introduction to Big Data

Practical work includes
- Building, creating and using a database
- Using GIS

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
    - Proficient
  - C2C2 : Solve and arbitrate
    - Intermediate
  - C2C3 : Think and act in an unpredictable and uncertain environments
    - Intermediate

Skills assessed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - Intermediate
  - Proficient

Sustainable Development Goals (SDGs) covered by this course

Quality education

Sustainable Development and Social Responsibility Positioning

The objective is to provide all students the ability to understand and to to model geographic information systems in the scope of improving their management.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	14 hrs	4 hrs	12 hrs	0 hrs	2 hrs

Urban atmosphere [ATMU]

LEAD PROFESSOR(S): Isabelle CALMET

Requirements

Physics and fluid dynamics – FLUID

Objectives

Provide the scientific knowledge necessary to understand the atmospheric processes that influence the microclimate and air quality, in interaction with natural and urban surfaces, and present the fundamental concepts and tools for analysing and developing strategies to mitigate the effects of urban densification and climate change on the quality of the atmospheric environment in urban areas.

Course contents

The first part of the course presents general knowledge about the atmosphere, covering:
- The context and issues
- Fundamental concepts about the processes involved (scales of atmospheric phenomena, turbulence, surface energy balance);
- Meteorological variables and simplified equations to characterise the dynamics and thermodynamics of the atmospheric boundary layer;
- The characteristics of the atmospheric boundary layer (wind, thermal and dynamic stability, turbulent fluxes, vertical structure during the diurnal cycle);
- The atmospheric surface layer (properties, Monin-Obukhov similarity theory and applications);
- The dispersion of pollutants in the atmospheric boundary layer (influence of wind and stability, Gaussian models and applications).

The second part of the course focuses more specifically on the atmospheric environment in urban areas at different scales (buildings, neighbourhoods, cities), presenting:
- Concepts and methods for studying the urban atmosphere (definitions of urban surfaces, scales of study and issues, complementarity of numerical modelling and experimental approaches);
- Air flows in urban environments (flow patterns around isolated buildings and in street canyons, wind in the atmospheric surface layer);
- The urban heat island phenomenon and its link to the urban surface energy balance;
- Principles of urban atmosphere modelling for the study of microclimate and air quality (computational fluid dynamics (CFD) models, atmospheric boundary layer models, operational air quality models).

Applications drawing on the general knowledge covered in the course are carried out during tutorials: practical use of surface layer similarity theory; development and performance evaluation of a pollutant dispersion model in the case of a real-site experiment; mini-project aimed at analysing the influence of different urban densification scenarios on the urban heat island, using a simplified model of urban surface energy balance.

Course material

Stull, R., 1988, An introduction to boundary layer meteorology, Kluwer Academic Press, Dordrecht/Boston/London
Oke, Mills, Christen and Voogt (2017) Urban Climates, Cambridge university press

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
    - Proficient
  - C2C2 : Solve and arbitrate
    - Intermediate
    - Proficient
  - C2C3 : Think and act in an unpredictable and uncertain environments
    - Intermediate

Skills assessed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - Intermediate
  - Proficient

Sustainable Development Goals (SDGs) covered by this course

Climate action / Goo health and well-being / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

The issue of sustainable development is addressed in the course in relation to air quality and the intensification of heat waves in urban areas, and as part of a mini-project on the influence of different urban densification strategies on the urban heat island

Assessment

Collective assessment: EVC 1 (coefficient 0.3)

Individual assessment: EVI 1 (coefficient 0.7)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	20 hrs	10 hrs	0 hrs	0 hrs	2 hrs

Heating, conditionning and air treatment [CCTAIR]

LEAD PROFESSOR(S): David CHALET

Requirements

Thermodynamics and Energy Systems (ENERG)

Objectives

The objective of this course is to study the different technical solutions to heat and cool the air of a building as well as solutions for obtaining domestic hot water.

Course contents

In the first part of the course, an introduction will present the different categories of heating and DHW systems and the role of each of the elements (generators, emitters, distribution systems). A complete presentation of the different conventional heat generators will be provided, as well as the generators using renewable energy (geothermal, aerothermal, aquathermal, wood, etc). The possible couplings between the different systems (heating and DHW), whether traditional or renewable, will be presented. Subsequently, the issue of water distribution will be covered (composition of the various circuits, materials, hydraulic balancing, regulation ...).
The second part of the course covers air conditioning. First, an overview will be provided (control of ambient temperature and humidity etc). Then, a load calculation is carried out in order to define the different air treatment operations. All technical solutions for treating air will be addressed. Real cases will be studied.
Practical sessions will be done with heat pump, air conditioning and solar collector systems.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
  - C2C2 : Solve and arbitrate
    - Intermediate
  - C2C3 : Think and act in an unpredictable and uncertain environments
    - Intermediate

Skills assessed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - Intermediate

Sustainable Development Goals (SDGs) covered by this course

Climate action / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

This course give the possibility to study various heating, cooling, and air-conditioning solutions for buildings, including the use of decarbonized/renewable energy sources. This is addressed both in lectures and tutorials, particularly through different applications.

Assessment

Collective assessment: EVC 1 (coefficient 0.3)

Individual assessment: EVI 1 (coefficient 0.7)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	10 hrs	8 hrs	12 hrs	0 hrs	2 hrs

Water and soil in urban environment [ESMU]

LEAD PROFESSOR(S): Isabelle CALMET / Katia CHANCIBAULT

Objectives

Gaining a better understanding of water and soil issues in urban areas for a more effective management.
Understanding hydrological, hydrodynamic, and geochemical processes and their interactions at interfaces in the urban environment. Understanding the challenges of adaptation strategies in the face of climate change and urbanization in terms of water flow management and water and soil quality in urban areas.

Course contents

The course is organised into three parts, covering the following topics:
Quantitative hydrology
- Water (a complex substance, where is it found on Earth?)
- The water cycle (processes, causes)
- Hydrology (links to human activities, definitions)
- Water cycle processes (precipitation: formation, measurement; interception: definition, measurement; évapotranspiration: definition, factors, concepts; infiltration; runoff: Hortonian runoff, on contributing surfaces)
- The watershed (definitions, different scales, hydrological response)
- The water cycle in urban areas (impacts on different processes; sewage systems: history, systems and types of networks, structures; stormwater basins and storm overflows: management and differences; source management structures: concept, examples; wastewater networks: drinking water, dynamics of wastewater network operation)
- Data processing methods and tools (interpolation, extrapolation, and disaggregation methods; statistical analyses: quantiles and intensity-duration-frequency curves)
- Dimensioning (estimation of rainfall, design rainfall, flows, network sections, and flow velocity

Rainwater quality
- Origin of water mineralisation
- Biogeochemical processes in aqueous environments
- Illustration of the calcareous system
- Carbon cycle
- Water quality and stormwater management

Management of polluted urban soils
- Issues of polluted soils in urban areas
- Pollutant mobility
- National methodology for polluted sites and soils management (guiding principles, diagnosis, remediation techniques)

Tutorials focus on different parts of the course:
Quantitative hydrology
- Strahler order of a hydrographic network
- Reservoir approach and concept of the water balance of a structure or watershed
- Spatialization of rainfall: Thiessen method
- Use of an abacus
- Practical application of quantiles, return periods, and IDF curves, based on a set of hourly data observed over a period of 7 years

Qualitative hydrology
- Ionic balance and water quality

Mobility of pollutants
- towards different environments (air, water, soil and subsoil)

- according to their intrinsic properties
- qualitative approach to the subsoil (and groundwater)

Case studies of soil pollution
- Sources of pollution on a site
- Development/interpretation of a conceptual model according to the source, vector, target principle
- Transfer velocity in groundwater
- Pollution management techniques (soil, groundwater)

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
  - C2C2 : Solve and arbitrate
    - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Clean water and sanitation / Climate action / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

The courses address concepts and techniques at the core of ecological and societal transition. In the context of sustainable cities, they provide knowledge on the health of the environment and the processes that impact it (climate change, pollution, etc.), as well as examples of sustainable water and soil resource management. From a societal perspective, all of this contributes to maintaining and/or improving the health and safety of citizens. These concepts are addressed throughout the course, depending on the topics (adaptation solutions, drinking water consumption) and during tutorials (e.g., use of IDF curves to assess the impact of climate change on rainfall).

Assessment

Collective assessment: EVC 1 (coefficient 0.3)

Individual assessment: EVI 1 (coefficient 0.7)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	22 hrs	8 hrs	0 hrs	0 hrs	2 hrs

Project 1 [P1PHYCITE]

LEAD PROFESSOR(S): Isabelle CALMET

Objectives

P1PHYCITE is the first part of an 80-hour project. The objective of the project is to explore a topic related to building or urban engineering in greater depth and to apply the knowledge and skills acquired in the specialization to practical situations. During the project students work in groups of 2 to 3.

Course contents

- Choice of topics: October
- Group work and progress meetings: October to January
- State-of-the-art report and project progress defence (P1): end of January
- Group work and progress meetings: February to March
- Final report and project defence (P2): end of March

Skills developed through this course

- C1 : Design and prototype innovative systems that create value
  - C1C1 : Develop
    - Intermediate
  - C1C2 : Dare
    - Intermediate
  - C1C3 : Deliver and create value
    - Intermediate
- C3 : Manage complex programmes or change responsibly
  - C3C1 : Design a project/programme
    - Intermediate
  - C3C2 : Manage/lead a project/programme
    - Intermediate
  - C3C3 : Finalise and leverage feedback
    - Intermediate

Skills assessed through this course

- C1 : Design and prototype innovative systems that create value
  - Intermediate
- C3 : Manage complex programmes or change responsibly
  - Intermediate

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Goo health and well-being / Industry, innovation and infrastructure / Responsible consumption and production / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

The projects focus on topics related to the subjects taught in the specialization. They may, for example, concern the energy renovation of buildings, the design of bioclimatic buildings, the use of renewable energies for air conditioning in buildings, and

the quality of the urban atmosphere (pollution, microclimate). All these topics are related to the issue of sustainable development.

Assessment

Collective assessment: EVC 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	1	0 hrs	0 hrs	0 hrs	32 hrs	0 hrs

Thermal performance of buildings [THBATP]

LEAD PROFESSOR(S): Alain MAIBOOM

Requirements

Building engineering - CONSTR

Objectives

This course aims to provide fundamental and practical knowledge for the study and design of building envelopes from a thermal point of view (both for building renovations and new constructions).

Course contents

This module presents calculation tools and methods to assess and size a building from a thermal point of view, first using a steady-state approach (annual cumulative energy balance), and then a dynamic approach (using dynamic thermal simulation software).
In the first part, a general introduction presents key concepts, the energy context of the building sector, and introduces the notion of thermal comfort. The main calculation methodologies of the "RE 2020 Environmental Regulation" are then presented, based on the steady-state assumption, including heat losses through opaque building components (walls, roof, floor), through thermal bridges, through glazed surfaces, and through air renewal. The different insulation strategies (internal insulation, external insulation, and distributed insulation) are presented. Similarly, strategies to reduce heat losses through thermal bridges and through air renewal (double-flow mechanical ventilation with heat recovery) are addressed.
In the second part, training on the Pleiades COMFIE software is provided. This software makes it possible to carry out dynamic thermal studies, which have become essential with the new regulations. In particular, it enables the analysis of issues related to summer thermal comfort.

Course material

[1] Ministère de la transition écologique, Chiffres clés de l'énergie, Édition 2021.
[2] ADEME, Climat, Air et Energie - Les chiffres clés, 2018.
[3] J.-P. Oliva and S. Courgey, La conception bioclimatique: Des maisons économes et confortables en neuf et en réhabilitation. terre vivante, 2006.
[4] ADEME, Le confort d'été - Guide de l'ADEME. 2007.
[5] Ministère de la transition écologique et de la cohésion des territoires, Guide RE2020 - Eco-construire pour le confort de tous.
[6] Guide pratique CSTB: Les ponts thermiques dans le bâtiment - mieux les connaître pour mieux les traiter
[7] RE 2020 et rénovation énergétique - Guide pratique pour les bâtiments neufs et existants - Maisons et copropriétés - Sénova - Collection Eyrolles Environnement

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
    - Proficient
  - C2C2 : Solve and arbitrate
    - Intermediate
    - Proficient
  - C2C3 : Think and act in an unpredictable and uncertain environments
    - Intermediate
    - Proficient

Skills assessed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - Intermediate
  - Proficient

Sustainable Development Goals (SDGs) covered by this course

Climate action / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

This course addresses aspects related to the comfort of occupied spaces and the reduction of their energy consumption and carbon footprint.

Assessment

Collective assessment: EVC 1 (coefficient 0.3)

Individual assessment: EVI 1 (coefficient 0.7)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	22 hrs	8 hrs	0 hrs	0 hrs	2 hrs

Architectural and environmental acoustics [ACARE]

LEAD PROFESSOR(S): Isabelle CALMET / Pierre AUMOND

Objectives

This course has three objectives: (i) to provide students with a general scientific understanding (both theoretical and practical) of environmental acoustics, (ii) to train them in the use of certain tools (experimental and numerical) and operational methods, (iii) familiarise them with major societal issues, current research topics and scientific challenges in environmental acoustics.

Course contents

The course takes the form of lectures and tutorials covering physical phenomena, theoretical approaches, experimental and digital tools, research topics and operational applications, and is divided into 8 parts:
General objectives and issues, from mechanics to physical and theoretical acoustics, indicators, noise and health
Characteristics of sound sources in environmental acoustics (urban environment, wind turbine noise, etc.)
Propagation in complex outdoor environments and introduction to the European 'CNOSSOS propagation' model
Introduction to the European 'CNOSSOS emission part' model, and application on NoiseModelling open source software
Characterisation of urban sound environments: indicators, measurement networks, modelling chains, citizen and participatory science
Psychoacoustics, physioacoustics, health effects of noise, perception of sound environments, soundscape
Room acoustics and application
Building acoustics and application

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
    - Proficient
  - C2C2 : Solve and arbitrate
    - Intermediate
    - Proficient
  - C2C3 : Think and act in an unpredictable and uncertain environments
    - Intermediate
    - Proficient

Skills assessed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - Proficient

Sustainable Development Goals (SDGs) covered by this course

Goo health and well-being / Industry, innovation and infrastructure / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

Issues of sustainable development and social responsibility are addressed in the course through several perspectives: effects of noise on health, acoustic impacts of infrastructure (wind turbine noise, road noise, rail noise, industrial noise), mobility patterns (urban and peri-urban), etc.

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	20 hrs	10 hrs	0 hrs	0 hrs	2 hrs

Urban planning and transportation [ATRAN]

LEAD PROFESSOR(S): Isabelle CALMET

Objectives

This course, in two parts, adresses issues relating to waste prevention, management and recovery at the local authority level, as well as those relating to transport and urban mobility.

Course contents

Waste management and recovery:
- Issues of waste management
- From waste reduction to recovery: current solutions
- Evolution of regulations
- Organization and management methods in a territory (example of Nantes Métropole)
- Recovery of waste for energy production

Transport and mobility:
- Introduction: Issues, regulatory framework, stakeholders, public policies and planning
- Evaluation of transport projects: Introduction to the evaluation process and tools
- Traffic theory, regulation and dynamic modelling
- Smart transport
- Public transport and alternative modes (service offer and uses)
- Road sharing - urban design

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
    - Proficient
  - C2C2 : Solve and arbitrate
    - Intermediate
    - Proficient

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Industry, innovation and infrastructure / Responsible consumption and production / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

The issue of sustainable development is addressed in the course through the topics of waste management and recovery, and urban mobility (particularly in terms of planning and sustainable mobility), which are important levers for ecological transition.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	30 hrs	0 hrs	0 hrs	0 hrs	2 hrs

Energy at the city scale [ENEVI]

LEAD PROFESSOR(S): Auline RODLER / Isabelle CALMET

Objectives

The city concentrates uses and therefore energy consumption. Most construction and renovation projects are carried out in urban areas, in a context of increasing density, and it is well known that taking this environment into account is necessary both in building design and in the evaluation of the proposed technical solutions. Moreover, a large share of projects concerns the scale of the block or the neighbourhood, at which specific energy strategies can be implemented, such as energy networks and shared systems. Finally, in a context of global warming and the emergence of urban heat island (UHI) phenomena, the energy design and the climatic design of neighbourhoods must be carried out jointly. Indeed, certain technical solutions, such as external thermal insulation, may exacerbate UHI effects, while urban cooling solutions may increase winter energy demand.
This module aims to:
- demonstrate what thermal design of a building or a group of buildings in an urban context entails;
- simulate how urban densification affects local climatic conditions around buildings;
- understand the principles of tools used to address energy management and urban climate at the neighbourhood or building stock scale (statistical approaches, simplified thermal simulation);
- address large-scale field methods for energy diagnosis (typological approaches, infrared remote sensing);
- address issues of energy distribution at the neighbourhood or city scale (urban energy networks, including district heating networks).
Ultimately, the objective is to acquire knowledge of the full range of tools used to assess the energy impact of urban density (gains and losses related to building compactness on envelope performance and on the potential use of natural resources), which can then be weighed against the gains associated with energy use for transportation.

Course contents

The course presents the various concepts and fundamental knowledge:
- Introduction
- Fundamentals of building thermal science
- Fundamentals of urban thermal science
- Calculation of a building's energy consumption in an urban context
- Calculation of energy consumption at the city scale
- Networks
Exercises help to assimilate the various concepts:
- Passive solar wall: solar calculations and energy balance
- Generation of a climate file accounting for the Urban Heat Island (UHI) effect
Applications relating to real urban sites are carried out during tutorials in the form of mini-projects:
- Feasibility study of connecting a neighbourhood to an urban network
- Calculation of energy consumption at the city scale: impact of densification

Course material

Urban Microclimate Modelling for Comfort and Energy Studies. Editors: Massimo Palme, Agnese Salvati. Springer

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
    - Proficient
  - C2C2 : Solve and arbitrate
    - Intermediate
    - Proficient
  - C2C3 : Think and act in an unpredictable and uncertain environments
    - Intermediate
    - Proficient

Skills assessed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - Intermediate
  - Proficient

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Industry, innovation and infrastructure / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

This course focusses on the environmental pillar of sustainable development (preserving natural resources and protecting ecosystems) by examining the impact of urban planning on cities' energy consumption and its consequences for the climate. The course introduces various solutions for urban cooling, helping to reduce reliance on air-conditioning systems and the production of anthropogenic emissions. The energy sources presented, which are relevant to urban networks (tutorial applications), are also designed to support the preservation of natural resources.

Assessment

Collective assessment: EVC 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	20 hrs	12 hrs	0 hrs	0 hrs	0 hrs

project 2 [P2PHYCITE]

LEAD PROFESSOR(S): Isabelle CALMET

Objectives

P2PHYCITE is the second part of an 80-hour project. The objective of the project is to explore a topic related to building or urban engineering in greater depth and to apply the knowledge and skills acquired in the specialization to practical situations. During the project students work in groups of 2 to 3.

Course contents

- Choice of topics: October
- Group work and progress meetings: October to January
- State-of-the-art report and project progress defence (P1): end of January
- Group work and progress meetings: February to March
- Final report and project defence (P2): end of March

Skills developed through this course

- C1 : Design and prototype innovative systems that create value
  - C1C1 : Develop
    - Intermediate
  - C1C2 : Dare
    - Intermediate
  - C1C3 : Deliver and create value
    - Intermediate
- C3 : Manage complex programmes or change responsibly
  - C3C1 : Design a project/programme
    - Intermediate
  - C3C2 : Manage/lead a project/programme
    - Intermediate
  - C3C3 : Finalise and leverage feedback
    - Intermediate

Skills assessed through this course

- C1 : Design and prototype innovative systems that create value
  - Intermediate
- C3 : Manage complex programmes or change responsibly
  - Intermediate

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Goo health and well-being / Industry, innovation and infrastructure / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

The projects focus on topics related to the subjects taught in the specialization. They may, for example, concern the energy renovation of buildings, the design of bioclimatic buildings, the use of renewable energies for air conditioning in buildings, and the quality of the urban atmosphere (pollution, microclimate). All these topics are related to the issue of sustainable

development.

Assessment

Collective assessment: EVC 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	2	0 hrs	0 hrs	0 hrs	48 hrs	0 hrs

Building technology [TECBA]

LEAD PROFESSOR(S): Isabelle CALMET

Requirements

Building engineering - CONSTR

Objectives

▪ To provide the fundamentals that guide overall design of the building structure from a mechanical point of view but also according to the technologies used both in terms of materials and constructive components;
▪ To present and apply the basic concepts of traditional construction and timber construction;
▪ To address issues related to construction pathology and builder's liability and insurance;
▪ To present the regulatory and methodological framework of Life Cycle Assessment in the building sector and the various eco-design levers.

Course contents

▪ Overall design of the building structure
  - Load-bearing function of the structure
  - Stability of the structure
  - Ground foundation of the structure
▪ Timber construction
  - Timber as a material
  - Solid Timber and Engineered Timber
  - Construction systems (traditional, roof framing, walls, floors)
  - Regulatory overview
  - Design and dimensioning of a timber framing structure
▪ Building pathology
  - Condensation
  - Wood pathology
  - Waterproofing / Water infiltration
  - Indoor floor coverings
  - Clay shrinkage and swelling
  - Radon
▪ Liability and insurance of builders
▪ Life Cycle Assessment in the building sector
  - Reminders on Life Cycle Assessment
  - Regulatory framework for buildings in France
  - Existing tools and databases
  - Key principles of eco-design
  - Integration of issues related to the circular economy

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
  - C2C1 : Represent and model
    - Intermediate
  - C2C2 : Solve and arbitrate
    - Intermediate
  - C2C3 : Think and act in an unpredictable and uncertain environments
    - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Responsible consumption and production / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

Part of the course focuses on timber construction technology, eco-design principles and life cycle analysis applied to the building sector, which highlight the use of renewable and low-carbon materials, thereby raising awareness of more environmentally responsible and sustainable building design.

Assessment

Collective assessment: EVC 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	20 hrs	12 hrs	0 hrs	0 hrs	0 hrs