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# ENGINEERING PROGRAMME

2021-2022

2nd year / 3rd year

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Specialisation option

Engineering Science for Housing  
and Urban Environment

OD PHYCITE

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PROGRAMME SUPERVISOR

Isabelle CALMET



# 1st Semester

Course unit	ECTS Credits	Track	Course code	Title
UE 73 / 93	12	Core course	CONSTR EVT PRURB SINBAD	Building Engineering Ecology, City and Territories Urban issues Geographic Information Systems and Databases
UE 74 / 94	13	Core course	ACECE ENERGUR HATUR IBIM P1PHYCITE	Acoustics, light and solar radiation Applied thermodynamics for urban engineering Urban hydrology and atmosphere BIM Initiation project 1

# 2nd Semester

Course unit	ECTS Credits	Track	Course code	Title
UE 103 / 83	14	Core course	P2PHYCITE	project 2
		Track: Housing	CTAIR MATHA TECBA THBATP	Air treatment and conditioning Materials for Building Comfort Building technology Thermal performance of buildings
		Track: Urban engineering	ATRAN ENEVI GENUI HATUA	Waste management & transportation engineering Energy at the city scale Noise management Applied Urban hydrology and atmosphere

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 1st Semester - Course Unit 73 / 93

# 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
- Strength of materials
- Basics of reinforced concrete beams
- Soil mechanics - in-situ tests, shallow foundations, deep foundations

### 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.

### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 1st Semester - Course Unit 73 / 93

# Ecology, City and Territories [EVT]

LEAD PROFESSOR(S): *Géraldine MOLINA / Isabelle CALMET*

### Objectives

In a context of heightened environmental concerns, this course aims to provide a skillset for engineers to tackle the major contemporary issues of manufacturing, urban and regional management in order to implement ecological transition solutions. Inspired by the "engineering of nature" (Gilles Clément), the aim is to promote engineering training based on systemic environmental and social intelligence. The challenge is to train professionals capable of developing a multi-criteria approach to environmental issues in order to devise sustainable solutions that meet the challenges of ecological preservation and restoration, and the health and well-being of regional populations.

### Course contents

Lectures and tutorials will be conducted in class or during site visits to address the following four main cross-disciplinary topics:

1. Towards the sustainable city: urban planning models (manufacturing, management, lifestyles):
  - . general contextual elements: socio-history of the relationship between the city and the environment: evolution of urban planning models in relation to environmental, social, technical, economic developments; emergence of the question of the sustainable city and urban ecological transition.
  - . issues linked to economic crisis, change and transitions
  - . visit focused on the move towards the sustainable city and contemporary issues
2. The different stakeholders: occupations, organisations, urban ecological transition policies, etc.
  - . description of institutional, political and planning transition in cities
  - . city, energy and environment professionals: analysis of feedback from professionals, analysis of technical solution trajectories
3. Techniques for thinking about the transition:
  - . field surveys and data: taking into account a context to develop solutions adapted to the environment and the populations concerned
  - . socio-technical approaches: a range of scientific techniques from social sciences applied to engineering
  - . alternative technical systems: presentation of concrete examples and field visits
4. Social transitions: changes in lifestyles
  - . Inhabitants and lifestyles: recent developments in various areas (consumption, energy, transport, waste, mobility, etc.)
  - . People and lifestyles: exposure, vulnerability and adaptation strategies for climate change.

### Course material

- . Hébert Florent, 2015, Villes en transition : l'expérience partagée des Écocités, Marseille, Parenthèse.
- . Courgey Samuel, Oliva Jean-Pierre, 2006, La conception bioclimatique. Des maisons confortables et économes. En neuf et en réhabilitation, terre vivante.
- . Molina Géraldine, Musy Marjorie, Lefranc Margot, 2017, Les professionnels du bâtiment face aux défis énergétiques et environnementaux : compétences et pratiques en transition, Londres, ISTE Editions.
- . Mathieu RIVAT, 2017, Ces maires qui changent tout. Le génie créatif des communes, Actes Sud.

### Assessment

Collective assessment: EVC 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	18 hrs	14 hrs	0 hrs	0 hrs	0 hrs

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 1st Semester - Course Unit 73 / 93

### Urban issues [PRURB]

LEAD PROFESSOR(S): Myriam SERVIERES / Pascal JOANNE

#### Objectives

The organic metaphor which compares the city to a living being and the mechanistic metaphor which sees it as a multiform and multi-scale system of flows and exchanges, show on the one hand mankind's fascination with the phenomenon of urbanisation, and on the other hand, summarise its great complexity. As an introduction to the following modules, this course aims to capture some of the keys to this complexity and attempt to explain what makes the city today. It will highlight the problems of adaptation and reaction to natural and climatic phenomena in the urban environment.

#### Course contents

The course is divided into two main parts which are dealt with in parallel in the form of weekly lectures and tutorial work. A historical perspective, or "history of the city" describes and analyses the different ways in which cities are created. The second part of the course covers the main issues linked to the development of modern-day cities.

#### Course material

Panerai, Philippe. 1999. Analyse urbaine. Paris: Parenthèse  
 Jean-Marc Stébé et Hervé Marchal (sous la dir. de). 2009. Traité sur la ville. Paris: Presses universitaires de France  
 Levy, Albert (sous la direction de). 2012. Ville, urbanisme et santé. Editions Pascal. Mutualité Française  
 Vincent Fouchier et Pierre Merlin. 1994. Les fortes densités urbaines: une solution pour nos villes? Hong Kong.  
 Sabine Barles. 2005. L'invention des déchets urbains. Seyssel: Champ Vallon.

#### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 1st Semester - Course Unit 73 / 93

# 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
- Database security
- Introduction to PL/SQL
- GIS and spatial databases
- Introduction to XML and Spatial Data Infrastructure

Practical work includes

- Building, creating and using a database
- GIS use

### Course material

### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 1st Semester - Course Unit 74 / 94

# Acoustics, light and solar radiation [ACECE]

LEAD PROFESSOR(S): Isabelle CALMET

## Objectives

This course is divided into 3 parts dealing with acoustics, daylighting and solar radiation.

### Part 1 - Acoustics

The objective of this course is to introduce the fundamental concepts of physical acoustics, to provide the basic knowledge required to successfully design the acoustics of a building, and to present the physiological mechanisms of hearing, the main elements of sound perception and the effects of noise on health.

### Part 2 - Daylighting

This part of the course develops the understanding of daylighting in the fields of architecture and urban planning. The objective is to understand which physical and radiative phenomena are sources of natural light and its distribution. This leads to managing natural light strategies for architectural and urban projects, which implies analysing the control and distribution devices of natural light. These physical aspects will be completed by an analysis of visual comfort, which uses more subjective concepts mostly related to user behaviour. To estimate the photometric parameters related to the control of natural illumination, the course will focus on more or less complex design tools, from in situ measurement to predictive computing tools. Some real examples will be presented. Practical sessions will lead students to confront the sensitive aspects to on-site measurements.

### Part 3 - Solar Radiation

The third part of the course deals with the nature of solar movements that reveal the potential of sunshine duration and the solar energy resources of a site or a built space. We start by considering the solar dimension throughout history. Then theoretical knowledge of solar geometry facilitates the use of simple control techniques and the evaluation of the period of sunshine for the various components of the building and the urban spaces. To estimate solar contributions, a number of various techniques will be presented ranging from the construction of manual drawings to the use of solar diagrams, as well as computing methods and tools. Practical sessions will focus on using these tools to build and analyse shade, to define sunshine duration or to estimate the influence of distant masks and protective devices on energy contributions.

## Course contents

### Part1 - Acoustics:

- Physical acoustics:
  - Elements of acoustics
  - Basic equations and principles
  
- Room and building acoustics
  - Reverberation time
  - Other criteria related to the acoustic quality of rooms
  - Absorbent materials
  - Isolation / Attenuation
  - Tools for room and building acousticians
  - Practical solutions for implementation
  
- Psychoacoustics and noise effects
  - Physical description of noise
  - Physiological dimension of noise
  - Elements of psychoacoustics
  - Auditory effects of noise
  - Extra-auditory effects of noise

### Part 2 - Daylighting

- Direct and diffuse light
- Normalized skies and lighting simulation methods
- Light reflection: colour and texture of materials
- Photometry
- Perception and comfort, contrast, glare
- Daylight factor

### Part 3 - Solar Radiation

- History of the consideration of sunlight in architectural and urban design
- Solar geometry
- Construction and use of solar diagrams
- Solar simulation algorithms
- Examples of solar simulation using SOLENE software

## Course material

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- Derek Phillips (2004), Daylighting, Natural Light in Architecture, Elsevier Eds.
- Mohamed Boubekri (2008), Daylighting, Architecture and Health, Elsevier Eds.
- Jennifer O'Connor (1997), Tips for Daylighting with Windows, LBNL-39945
- Edward Mazria (1981), Le guide de l'énergie solaire passive, Parentheses Eds.
- Garry Stevens (1990), The reasoning architect : Mathematics and Science in Design, McGraw-Hill Eds.
- Sophia Behling and Stefan Behling (2000), Solar Power: The Evolution of Sustainable Architecture, Prestel Pubs.

## Assessment

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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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 1st Semester - Course Unit 74 / 94

# Applied thermodynamics for urban engineering [ENERGUR]

LEAD PROFESSOR(S): Jean-François HETET

### Objectives

This course aims to bring skills and knowledges on energy issues with a particular focus on urban and housing applications

### Course contents

First courses are focusing on thermal losses of a building calculation and then a complete energy balance of a building will be considered including heating by a heat pump and thermal solar captation.

Then labs are organized : heat pump, A/C system, thermal transfer and thermal solar energy

Finally, presentations by the students about energetic issues linked to urban environment are programmed : wood energy, smart grid, P2V, Power to gas, RME, regulations, energy storage, nuclear energy (SMR), geothermal energy, solar energy, wind energy, heat networks.

### Course material

Thermodynamique et énergétique par M. BOREL (Presses polytechniques Romandes)

Thermodynamique générale et application par R. KLING (Technip)

Thermodynamique par J.P. PEREZ (Masson)

Energétique par M. FEIDT (Dunod)

Introduction aux problèmes énergétiques globaux par R. GICQUEL (Presses des Mines)

### Assessment

Collective assessment: EVC 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	20 hrs	4 hrs	8 hrs	0 hrs	0 hrs

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 1st Semester - Course Unit 74 / 94

# Urban hydrology and atmosphere [HATUR]

LEAD PROFESSOR(S): Isabelle CALMET

### Objectives

To provide scientific concepts necessary to understand the atmospheric, hydrologic, geochemical and hydrodynamic processes, and their interactions with soil-surface-atmosphere interfaces influencing the microclimate and air, water and soil quality in natural or urban areas.

### Course contents

#### Part 1 - Hydrology

- Water cycle: water and matter fluxes
- Hydrographical networks and water transfer processes (atmosphere-surface-soil)
- Composition of natural waters, biogeochemical cycles, components and soil reactivity
- Mass transfer processes in-soils
- Urban environment specificities: water cycle modifications, sewer networks, urban water, waste water, urban pollution

#### Part 2 - Atmosphere

- Urban atmosphere: issues and context
- Atmospheric boundary layer simplified equations
- Basic knowledge of turbulence, statistical tools and characteristic scales
- Dynamics of the atmospheric boundary layer: stability, diurnal cycle, and influence on plume dispersion
- Surface layer processes: energy balance, similarity theory
- Introduction to urban specificities and influence on the energy budget

### Course material

- Stull, R., 1988, An introduction to boundary layer meteorology, Kluwer Academic Press, Dordrecht/Boston/London
- Laura Sigg, Werner Stumm, Philippe Behra (2014) Chimie des milieux aquatiques - Cours et exercices corrigés - Master, écoles d'ingénieurs - Collection Sciences sup

### Assessment

Individual assessment: EVI 1 (coefficient 0.5)  
EVI 2 (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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 1st Semester - Course Unit 74 / 94

### 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 teaching is based in particular on the learning of 3D parametric modelling software (REVIT) that incorporates BIM concepts. Approached in a logic of production of architectural projects, the course will allow to apprehend the methods of modelling and structural and constructive design, and to fill in the project and the data in a perspective of management and exploitation 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

#### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 1st Semester - Course Unit 74 / 94

### 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 city or building engineering, and to use the knowledge and skills acquired in the specialization. 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
- Project progress defence (P1): end of January
- Group work and progress meetings: February to March
- Final report and project defence (P2): end of March

#### Course material

#### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 2nd Semester - Course Unit 103 / 83

### 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 city or building engineering, and to use the knowledge and skills acquired in the specialization. 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
- Project progress defence (P1): end of January
- Group work and progress meetings: February to March
- Final report and project defence (P2): end of March

#### Course material

#### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 2nd Semester - Course Unit 103 / 83

# Waste management & transportation engineering [ATRAN]

LEAD PROFESSOR(S): Isabelle CALMET

### Objectives

This course, in two parts, deals with waste management and recovery, and urban transport engineering.

### 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)
- Methanization

Transport Engineering

- Introduction: Actors, regulatory framework and planning
- Multimodal modelling: static displacement modelling
- Evaluation of projects and public policies
- Traffic engineering and dynamic modelling
- Intelligent transport
- Public transport and alternative modes (service offer and uses)
- Road sharing - urban design

### Course material

### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 2nd Semester - Course Unit 103 / 83

# Energy at the city scale [ENEVI]

LEAD PROFESSOR(S): Isabelle CALMET / Marjorie MUSY

### Objectives

Cities account for a high proportion of energy use and therefore energy consumption. Most constructions and renovations are carried out in urban areas, within a context of densification, and we know that it is necessary to take this environment into account both in the design of buildings and the evaluation of proposed technical solutions. Furthermore, most urban projects concern an entire urban block or district, which are suitable for specific energy strategies: networking, sharing... Finally, in a context of global warming in which urban heat island phenomena (UHI) are more intense, the design of energy and climate within a district should be carried out simultaneously. Indeed, it has been proved that some technical solutions such as external thermal insulation enhance UHI phenomena and that some outdoor cooling solution could rise the buildings' energy needs. The course aims to:

- show the issues associated with thermal design of a building or group of buildings in urban areas
- understand the principles of the tools that can be used to address energy management from building scale to that of a building stock (statistical approaches, simplified thermal simulation)
- address large-scale energy diagnostic field methods (typological approaches, infrared remote sensing)
- address heating networks, but also smart grids.

At the conclusion of the course students should know the range of tools necessary to evaluate the energy impact of urban density (gains and losses related to the compactness of the urban frame on the envelopes' efficiency and potential use of natural resources) which can then be balanced against the gains linked to the use of energy for transportation.

### Course contents

- Physical phenomena on building and district scale
- Impact of building on its environment and retroaction
- Urban energy models
- Large-scale energy diagnosis
- Urban energy networks

### Course material

Beckers, B. (Ed.), Solar Energy at Urban Scale, ISTE, 2013, 384 p.

Robinson, D., Computer Modelling for Sustainable Urban Design: Physical Principles, Methods and Applications, Routledge, 2011, 320p.

### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 2nd Semester - Course Unit 103 / 83

# Noise management [GENUI]

LEAD PROFESSOR(S): Isabelle CALMET

### Objectives

This course is divided into two distinct parts dealing, on the one hand, with noise and, on the other hand, with polluted soils in urban areas. It provides the legislative, methodological and technical bases for identifying these nuisances and providing solutions in terms of reduction and remediation.

### Course contents

#### Part 1: Noise in urban areas

- Impact of urban mobility on sound environments and noise reduction
  - The problem of noise pollution in cities
  - General aspects of urban noise environments
  - Indicators of environmental acoustics
  - Characterisation of urban noise environments: models and measurements
- Urban Acoustics and Soundscape
  - Soundscape
  - Urban Acoustics
  - Means to reduce urban noise
  - Perception of sound environments (research and field)
  - Representations of sound environments
- Noise sources in urban areas - Tyre/road contact noise
  - Review of noise, units and indicators in environmental acoustics
  - Characteristics of urban noise sources (key figures, regulatory aspects, emission properties of road traffic noise)
  - Tyre/road contact noise (physical phenomena, methods of measuring rolling noise, modelling rolling noise, influence of road surface)
- Environmental acoustics
  - Experimental demonstration of physical phenomena
  - Theoretical approach to ground effects on sound propagation
  - Theoretical approach to atmospheric effects on sound propagation
  - Numerical modelling
  - Uncertainties

#### Part 2 : Management of polluted sites and soils in urban areas

- Context and issues related to polluted sites and soils in urban areas
- National methodology for the management of polluted sites and soils:
  - inventories of (potentially) polluted sites;
  - approach to polluted soil management from diagnosis to management methods, including remediation techniques.
- Practical application via a case study of the various concepts addressed in the course

### Course material

### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 2nd Semester - Course Unit 103 / 83

# Applied Urban hydrology and atmosphere [HATUA]

LEAD PROFESSOR(S): Isabelle CALMET

### Objectives

To provide the knowledge required to develop mitigation strategies for water flows and treatment techniques of urban water and soil. Provide the knowledge necessary to study and develop mitigation strategies of urban microclimate and air quality in view of adapting the city to changes (climate, densification).

### Course contents

#### Part 1 - Hydrology

- Instrumentation and measurement in quantitative and qualitative hydrology (in situ, under laboratory conditions)
- Data treatment methodologies and tools (geostatistics, abacus, standards)
- Water uses and regulation on water quality
- Soil functions and soil artificialisation
- Treatment techniques and numerical models:
  - Sewer devices and SUDs (sustainable urban devices)
  - Processes of water treatment in WWTP (waste water treatment plant)
  - Pollutant transfer models
  - Hydrological models

#### Part 2 : Atmosphere

- Scales and approaches for the study of urban atmosphere.
- Flow and pollutant dispersion at the street-scale.
- Wind tunnel studies for urban planning assessment.
- Urban heat island
- Methods and models to represent interactions between the city and the lower atmosphere; application on the influence of urban planning scenarios on the energy budget.
- Basic models for the study of pollutant dispersion at the city scale.

### Course material

- Oke, Mills, Christen and Voogt (2017) Urban Climates, Cambridge university press
- <https://www.inrae.fr/actualites/sols-artificialises-processus-dartificialisation-sols>

### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 2nd Semester - Course Unit 103 / 83

# Air treatment and conditioning [CTAIR]

LEAD PROFESSOR(S): David CHALET

### 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

The first part of the course starts with a presentation of the different systems which can be used for heating and domestic hot water production as well as the role of each element. A complete presentation of the different conventional heat generators (classification of boilers, water heater, looping hot water and regulations) as well as generators using renewable energy (geothermal, aerothermal, aquathermal, solar, wood, etc.) will be provided. Subsequently, our attention will turn to water distribution (composition of the various circuits, materials, hydraulic balancing, regulations etc.). This part will conclude with implementation of practical examples and a company visit.

The second part of the course focuses on air conditioning. First, an overview will be provided (control of temperature and humidity, etc). Then, a load calculation is carried out in order to define the different air treatment operations. All technical solutions will be covered followed by a real case study.

### Course material

### Assessment

Collective assessment: EVC 1 (coefficient 0.2)

Individual assessment: EVI 1 (coefficient 0.8)

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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 2nd Semester - Course Unit 103 / 83

# Materials for Building Comfort [MATHA]

LEAD PROFESSOR(S): Alain MAIBOOM

### Objectives

The design of the envelope of a building requires a good knowledge of the behavior of the materials involved, in particular the insulation materials. This course describes the physical properties of insulation materials to control the transfer of humidity, heat and noise. The different insulation techniques for the implementation of insulators are described; their environmental impact is also addressed through life cycle assessment.

### Course contents

- Humidity transfer through the walls of a building:
  - Humid air and water vapour permeability of materials
  - Rules of implementation
  - Examples of walls
- Material properties for thermal insulation:
  - Heat transfers through the walls
  - Insulation: presentation of the different insulation materials and application techniques
- Acoustic insulation :
  - Acoustic physics in construction, regulations and labels.
  - Construction systems: diversity of materials and assembly methods that influence their acoustic properties.
  - Building comfort or how to reconcile acoustics, thermal insulation and ventilation.
- Life cycle assessment of materials:
  - Principle of LCA
  - Calculation rules and INIES data base
  - French environmental regulation RE2020
- Bio-sourced materials :
  - Properties of bio-sourced materials and their use in buildings

### Course material

- Transferts d'humidité à travers les parois, Guide technique CSTB
- Cours de thermique du bâtiment (THBATP)

### 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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 2nd Semester - Course Unit 103 / 83

# Building technology [TECBA]

LEAD PROFESSOR(S): Isabelle CALMET

### 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 the basic concepts for the realisation of timber constructions;
- To address issues related to construction pathology and builder's liability and insurance;
- To present reinforcement and improvement techniques aimed at ensuring the stability of structures, according to the types of soil and structure;
- To present the geotechnical aspects and implementation techniques of underground works intended for the movement of people, vehicles and goods or fluids, in increasingly complex contexts linked to growing urbanisation, the increase in the density of the urban fabric and the value of space, the increasing scarcity of available space, the concern to reduce the nuisance to local residents during works and the sensitivity of the population to the environment.

### Course contents

- Overall design of the building structure :
  - Load-bearing function of the structure
  - Stability of the structure
  - Ground foundation of the structure
- Introduction to Timber construction :
  - Timber Construction at BYCN
  - Solid Timber and Engineered Timber
  - Building Systems
  - Regulatory Context
- Building disease :
  - Condensation
  - Wood disease
  - Water ingress
  - Floor coverings
  - Removal and inflation of clay soils
  - Radon
- Liability and insurance of builders
- Soil improvement and reinforcement technics :
  - Introduction, complex soils, tests and instrumentation
  - Compaction techniques
  - Reinforcement techniques
  - Treatment techniques
- Introduction to underground works :
  - The general context of underground work
  - Geotechnical aspects of underground works
  - Construction techniques
  - "Traditional" methods with or without "land treatment"
  - Mechanized methods: tunnel boring machines
  - Geotechnical approach of a tunnel project
  - The role of site monitoring and auscultations

## Course material

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## Assessment

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Individual assessment: EVI 1 (coefficient 1)

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

## ENGINEERING - OD PHYCITE

2nd year / 3rd year - 2nd Semester - Course Unit 103 / 83

# Thermal performance of buildings [THBATP]

LEAD PROFESSOR(S): Pierre MARTY

### Objectives

This course provides fundamental practical knowledge for the design of building envelopes from a thermal perspective (new builds and thermal renovation of existing buildings).

### Course contents

The course outlines the tools and calculation methods to approach the design of a building from a thermal perspective, using a steady-state method and a dynamic simulation method.

The first part of the course (18hrs) begins with an overview of the main ideas, some key figures, the energy context for the building sector and introduces the concept of thermal comfort. Then the course addresses the main calculation methods within the regulatory context (RT 2012), with steady-state assumption, heat loss through the envelope, how to insulate a building etc. Strategies to curb heat loss via thermal bridges and air exchange (double flow ventilation) are also covered.

In the second part (12hrs) training is provided on how to use Pleiades COMFIE software, which is used to perform dynamic thermal simulations of buildings, essential in the new regulatory environment. It can be particularly useful for the estimation of thermal comfort and energy efficiency in the winter and summer months.

### Course material

Chiffres clés du bâtiment, édition 2013, ADEME

La conception bioclimatique: des maisons confortables et économes en neuf et en réhabilitation, Samuel Courgey and Jean-Pierre Oliva, édition Terre Vivante 2006

Guide pratique CSTB: Les ponts thermiques dans le bâtiment - mieux les connaître pour mieux les traiter

### Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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