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CENTRALE NANTES

ENGINEERING PROGRAMME

SPECIALISATION

ENGINEERING SCIENCE FOR HOUSING AND URBAN ENVIRONMENT

SPRING SEMESTER

Établissement public sous tutelle du
ministère de l'Enseignement supérieur, de la Recherche et de l'Innovation

GROUPE **CENTRALE**

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THERMAL PERFORMANCE OF BUILDINGS

ENGINEERING SCIENCE FOR HOUSING AND URBAN ENVIRONMENT, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: Alain MAIBOOM

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). Both heat losses and heat gains (passive solar collection) through the envelope are presented.

Course contents

This course presents tools and methodologies for the design of building envelopes with the aim of reducing heat losses while promoting passive solar collection. This course is composed of 4 parts:

- Part 1 (12hrs): key data for energy in buildings, definition of thermal comfort in buildings, regulatory context (RT 2012, zero-energy building, etc), heat transfers through the envelope (based on French RT 2012
- Part 2 (4hrs): passive solar collection and bioclimatic design.
- Part 3 (2hrs): ventilation and thermal losses.
- Part 4 (12hrs): training on the finite element method - application to the calculation of heat loss in steady state through a thermal bridge.

Course material

Chiffres clés du bâtiment, Edition 2013, ADEME

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

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

Keywords

Thermal comfort in a building, heat losses, thermal bridge, RT 2012, heat losses through ventilation, finite elements for thermal bridges calculation, passive solar collection, bioclimatic design

Links with other programmes

Applied thermodynamics, Air treatment and conditioning

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	22 hrs	8 hrs	0 hrs	0 hrs

AIR TREATMENT AND CONDITIONING

ENGINEERING SCIENCE FOR HOUSING AND URBAN ENVIRONMENT, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: 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

In the first part, an introduction will present the different systems which can be used for heating and domestic hot water production but also to present the objectives of each element. A complete presentation of the different conventional heat generators will be carried out (classification of boilers, water heater, looping hot water and regulation) without forgetting the generators using renewable energy (geothermal , aerothermal, aquathermal, solar, wood, ...). Subsequently, the water distribution will be studied (composition of the various circuits, materials, hydraulic balancing, regulation ...). This part will conclude with an implementation of practical examples and a company visit.

In the second part, air conditioning will be studied. First, an overview will be performed (control of the 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 studied.

Course material

Keywords

Cooling systems, Air treatment, Heat systems, Domestic hot water

Links with other programmes

Applied thermodynamics, Thermal performance of buildings

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	22 hrs	8 hrs	0 hrs	0 hrs

BUILDING TECHNOLOGY

ENGINEERING SCIENCE FOR HOUSING AND URBAN ENVIRONMENT, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: Yvon RIOU

Objectives

Within the housing and urban environment specialisation, the objective of this course is to convey an understanding of the design and construction of structures and their foundations. The autumn semester course in 'Building Engineering' covered the principles of basic calculation. This advanced course provides an understanding of the fundamentals that guide overall design from a mechanical point of view, but also the technology used by companies both in terms of tools and constructive components. This course also addresses maintenance work.

Course contents

This course will cover in turn: the different types of building structures, floor systems, walls, columns and beams and their construction methods, design in terms of settlement structures, foundations, groundwater, earth pressure, wind loads and earthquakes. Notions of overall site organisation, logistics, flow and planning will complement the course.

Course material

Keywords

Construction principles, building technology, maintenance

Links with other programmes

Building Engineering (autumn semester)

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	20 hrs	10 hrs	0 hrs	0 hrs

Materials for Building Comfort

Engineering Science for housing and urban environment, Engineering programme specialisation

Spring Semester

Professor: Frédéric GRONDIN

Objectives

The insulation of buildings requires sound knowledge of the behaviour of materials that make up the building envelope. Insulators have specific characteristics according to their use.
In this course we will study the physical properties of insulation to control moisture transfer, heat transfer and wave propagation. The implementation of insulation in buildings is also covered.

Course contents

Material Properties for airtightness (4hrs lectures, 4hrs tutorials)

- Part 1: Requirements habitat comfort, humid air, moisture transfer, Porous media.
- Part 2: outdoor climate, indoor climate, transfer evaluation, examples of walls.

Material properties for thermal insulation (4hrs lectures, 2hrs tutorials)

- Part 3: Mechanisms of heat transfer, insulator morphology
- Part 4: Thermal aging insulators, insulation properties, applications

- Part 5: building site visit

Material properties for sound insulation (6hrs lectures, 2hrs tutorials)

- Part 6: acoustic wave physics
- Part 7: Vibration plates, transmission-reflection-absorption
- Part 8: Materials for sound insulation, applications.

Civil engineering materials (4hrs lectures, 2hrs tutorials)

- Part 9: Properties of concrete
- Part 10: Properties of different materials of the building envelope

Course material

Keywords

Conductivity, diffusion, heat, water vapor, building, acoustic waves, materials, porous media.

Links with other programmes

Thermal Performance of Buildings, Air treatment and Conditioning, Building Engineering, Acoustics, Light and Solar Radiation

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	20 hrs	10 hrs	0 hrs	0 hrs

APPLIED URBAN HYDROLOGY AND ATMOSPHERE

ENGINEERING SCIENCE FOR HOUSING AND URBAN ENVIRONMENT, ENGINEERING PROGRAMME SPECIALISATION
SPRING SEMESTER

Professor: Béatrice BECHET

Objectives

To provide the knowledge required to develop mitigation strategies for water flows and treatment techniques of urban water and soil. Provide knowledge on the experimental and numerical approaches used to study micro-climatology and air quality processes with regard to city adaptation to change (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 and soil quality
- Treatment techniques and numerical models:
  - Sewer devices and SUDs (sustainable urban devices)
  - Processes and sizing in WWTP (waste water treatment plant)
  - Pollutant transfer models and remediation technologies
  - Hydrological models

Part 2 - Urban atmosphere

- Microclimate and dispersion at street-scale: knowledge from Computational Fluid Dynamics and real site experiments
- City scale: methods and models to represent interactions between city and atmosphere; Application to urban planning scenarios
- Wind tunnel studies for urban planning assessment

Course material

Keywords

Instrumentation, hydrological measurements and models, dimensioning, water and soil treatment, microclimate, urban planning scenarios, wind tunnel and in situ experiments, numerical modeling

Links with other programmes

Physics and fluid dynamics, Noise and waste management

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	20 hrs	10 hrs	0 hrs	0 hrs

ENERGY AT THE CITY SCALE

ENGINEERING SCIENCE FOR HOUSING AND URBAN ENVIRONMENT, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: Jean-Francois HETET

Objectives

Cities account for a high proportion of energy use and therefore energy consumption. Most construction and renovation is 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.

The course aims to:

- show the issues associated with thermal design of a building or group of buildings in urban areas
- show 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.

Keywords

Energy, infrared remote sensing, networks, UHI

Links with other programmes

Hydrology and urban atmosphere

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	20 hrs	10 hrs	0 hrs	0 hrs

NOISE MANAGEMENT

ENGINEERING SCIENCE FOR HOUSING AND URBAN ENVIRONMENT, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: Jean-Francois HETET

Objectives

This course is divided into two parts. The first part of the course deals with noise sources in urban areas and focuses mainly on the acoustical emissions of road traffic vehicles. The second part of the course will specifically address the problem of noise pollution in urban areas.

Course contents

Part 1 - Noise sources in urban areas:
After a brief review of indicators relative to environmental noise, the main characteristics of road traffic noise are presented. Legislative aspects are treated too. Noise sources for the different categories of road vehicles are described. A specific accent is put on tyre/road noise which is the main source of noise for light vehicles over 50 km/h. The lesson then deals with different means for abatement of road traffic noise, by acting on the source or on the propagation of sound.

Part 2 - Noise indicators and sound mapping in urban areas:
A presentation will be made of the indicators used to characterize noise in urban areas, and existing methods for evaluating the impact of noise reduction strategies.

Course material

Keywords

Noise sources, urban areas, noise indicators, sound mapping

Links with other programmes

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	20 hrs	10 hrs	0 hrs	0 hrs

WASTE MANAGEMENT & TRANSPORTATION ENGINEERING

ENGINEERING SCIENCE FOR HOUSING AND URBAN ENVIRONMENT, ENGINEERING PROGRAMME SPECIALISATION
SPRING SEMESTER

Professor: Yvon RIOU

Objectives

This course comprises two parts:

Part 1 Waste management - course delivered by Ademe, Veolia and Akajoule.
Part 2 Transportation engineering - course delivered by Cerema.

Course contents

Part 1 - Waste Management

- Introduction (2hrs) - Marc Janin, ADEME
- Waste context - management, prevention, strategy, sectors
- Composting (2hrs) - Christian Thomin, Véolia,
- Waste sorting (4hrs) - Christèle Renault, Véolia
- Selective sorting, optical sorting, automatic sorting, detection.
- Solid recovered fuels (4hrs) - Jérôme Auffret, Véolia
- Preparation and development
- Methanization (3hrs) - Pauline Dupont, Akajoule

Part 2 Transportation Engineering:

- Multimodal transport modelling (4hrs) - Eric Morau et Julien Harache, Cerema
  - General principles of trip and traffic modelling
  - Preparation of mobility data: different survey types
  - Building zones and private and public transport networks
  - Developing demand matrices: steps in trip generation, trip distribution and mode choice
  - Demand matrix assignment on the networks and feedback loop
  - Simulation of new perspective and projects

- Traffic management and microscopic traffic simulation (4hrs) - Simon Vrigneau, Cerema
  - General principles of traffic theory (understand, analyse and quantify congestion)
  - Presentation of measures used in microscopic traffic simulation (access control, speed control, lane control etc.)
  - Microscopic traffic simulation (operation, pros and cons, uses)

- Intelligent Transport Systems (4hrs) - Christophe Desnouailles, Cerema
  - Fundamental concepts, functionality and architecture
  - Overview of applications (road information, fault finding, network optimisation)
  - Cooperative systems and geographical positioning

- Rudiments of performance evaluation

- Roads for all (3 hrs) - Gilles Blanchard, Cerema:

Congestion, pollution, energy waste etc. over the last 30 years, despite the variety of uses of streets and public spaces, development projects have too often focused on the needs of car users, in terms of traffic, fluidity and parking. Streets are public spaces where no one type of user has exclusive rights over another. As such, developers must ensure that this space is shared properly between all users to promote alternatives to individual motorised vehicles.

Course material

Keywords

waste sorting, solid recovered fuels, mechanisation, traffic modelling, trip distribution, trip generation, demand matrix, congestion, intelligent transport, sharing public spaces

Links with other programmes

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	20 hrs	10 hrs	0 hrs	0 hrs

PROJECT 2

ENGINEERING SCIENCE FOR HOUSING AND URBAN ENVIRONMENT, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: Jean-Francois HETET

Objectives

To undertake group work on topics linked to urban and civil engineering.

Course contents

Examples of topics:

- inter seasonal energy storage
- positive energy houses
- logistic potential of the Loire river
- energy balance of the new Nantes international high school
- waste management
- micro algae and energy production
- human activity as an energy source
- collaborative design of a new district
- participation in the development of the SOLAR DECATHLON demonstrator

Course material

Keywords

project, teamwork

Links with other programmes

All the courses of the specialisation

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	2	0 hrs	0 hrs	0 hrs	48 hrs