



# ***Course Catalog – English taught program - Civil Engineering course descriptions***

# ***Semester 5 – Course descriptions***

## English-taught Program semester 5

| Teaching Unit (UE) | S5 Curriculum / Fall semester                                           | Study hours per Teaching Unit (UE) | Study hours per course | ECTS credits | Weighting in the UE |
|--------------------|-------------------------------------------------------------------------|------------------------------------|------------------------|--------------|---------------------|
| <b>UE INTEG</b>    | <b>Integration Seminar</b>                                              | <b>14,00</b>                       |                        | <b>1</b>     |                     |
| UE INTEG           | Integration Seminar                                                     |                                    | 14,00                  |              | 1                   |
| <b>UE ECD1</b>     | <b>Sustainable Construction Challenges</b>                              | <b>76,00</b>                       |                        | <b>6</b>     |                     |
| UE ECD1            | Energy Policies, Transition, and Engineering Project                    |                                    | 30,50                  |              | 2                   |
| UE ECD1            | Challenges for cities and territories                                   |                                    | 10,00                  |              | 1                   |
| UE ECD1            | Stakeholders and Challenges of the construction project                 |                                    | 25,50                  |              | 2                   |
| UE ECD1            | Business Economics                                                      |                                    | 10,00                  |              | 1                   |
| <b>UE MOD1</b>     | <b>Mathematics and Modeling</b>                                         | <b>45,00</b>                       |                        | <b>3</b>     |                     |
| UE MOD1            | <i>Mathematics (Refresher Course) - optional</i>                        |                                    | 0,00                   |              |                     |
| UE MOD1            | <i>Mathematics: Analysis and Algebra</i>                                |                                    | 30,00                  |              | 2                   |
| UE MOD1            | Digital Programming - Data Analysis                                     |                                    | 15,00                  |              | 1                   |
| <b>UE MM1</b>      | <b>Mechanics and Materials</b>                                          | <b>100,00</b>                      |                        | <b>8</b>     |                     |
| UE MM1             | Materials Science                                                       |                                    | 16,00                  |              | 2                   |
| UE MM1             | Construction Materials Engineering                                      |                                    | 27,50                  |              | 2                   |
| UE MM1             | Vibration Mechanics                                                     |                                    | 22,50                  |              | 2                   |
| UE MM1             | Continuum Mechanics                                                     |                                    | 34,00                  |              | 2                   |
| <b>UE STC1</b>     | <b>Construction Sciences and Techniques</b>                             | <b>100,00</b>                      |                        | <b>8</b>     |                     |
| UE STC1            | Technical Design of Structures and Eurocodes                            |                                    | 27,00                  |              | 2                   |
| UE STC1            | Planning and networks                                                   |                                    | 22,00                  |              | 2                   |
| UE STC1            | Thermodynamics                                                          |                                    | 23,00                  |              | 2                   |
| UE STC1            | Energy of Electrical Systems                                            |                                    | 28,00                  |              | 2                   |
| <b>UE SK1</b>      | <b>Communication and Professional Project</b>                           | <b>45,00</b>                       |                        | <b>4</b>     |                     |
| UE SK1             | Leadership & Communication 1                                            |                                    | 12,00                  |              | 2                   |
| UE SK1             | ESTP Professional Conferences                                           |                                    | 3,00                   |              | 0                   |
| UE SK1             | English                                                                 |                                    | 30,00                  |              | 2                   |
|                    | <i>French as a Foreign Language (international students) - optional</i> |                                    | 30,00                  |              |                     |
|                    | <i>Main Foreign Language (German or Spanish) - optional</i>             |                                    | 30,00                  |              |                     |
|                    | <i>Additional Foreign Language - optional</i>                           |                                    | 16,50                  |              |                     |
|                    |                                                                         | <b>380,00</b>                      |                        | <b>30</b>    |                     |

|                                                                                  |                                                              |                    |
|----------------------------------------------------------------------------------|--------------------------------------------------------------|--------------------|
|  | <i>Energy policies, transitions and engineering projects</i> | PGE1 S05 – UE ECD1 |
|                                                                                  |                                                              | 24/02/2026         |
|                                                                                  |                                                              | Page 1/2           |

**Teaching language: English**

**Number of hours: 30,5**

Lectures: 9h / Tutorials: 5h / Project: 15h /FOAD:1,5

### **Course description and assessment**

The module “**Energy Policies, Transitions and Engineering Projects**”, part of the core curriculum of the “**Management and Communication in Sustainable Construction**” teaching unit, addresses the geopolitical, economic, environmental, cultural and technical context of countries. This global vision enables students to analyse and propose choices for the energy transition, while taking into account the respective constraints of the countries studied. This module encourages students to apply systems thinking to engineering.

### **The objectives of this course:**

- ✓ **Understand** the geopolitical context, strategic issues, and problems of global warming at different scales;
- ✓ **Acquire** knowledge and skills on the topics of energy policy, transitions, global warming, resource depletion, secondary raw materials, low-carbon energies, and transport: advantages and constraints;
- ✓ **Understand** the role and place of an engineer in these transitions (ecological, energy, digital, etc.);
- ✓ **Adapt** to the current resources and levers available to countries, taking into account constantly evolving strategies, laws and regulations.

### **Decomposition of teaching:**

#### **Findings, current situation, causes and effects:**

- Context and challenges of global warming: causes and effects
- Understanding the local context (current energy mix, key demographic data, climate objectives of the country studied, socio-economic issues: inequalities, urbanisation, energy dependence, climate vulnerabilities: water stress, heat islands, etc.)
- Impacts on raw materials and associated risks
- Tools: IEA, IRENA, World Bank, Climate Action, Our World in Data

#### **Evolution, projection and adaptation:**

- How are countries adapting to climate change and policies that differ from one country to another? What levers are they using? What constraints are they taking into account?
- Based on existing solutions and levers, develop challenges between teams and the company:
  - Reducing greenhouse gas (GHG) emissions
  - Strengthening carbon sinks
  - Adapting to global warming
  - Preserving biodiversity
  - Participating in the circular economy
  - Identifying priority actions for buildings, industry and transport
  - Become a responsible engineer and citizen (CSR policy and governance)

Students will give a final presentation on their group project. They will propose and present a master plan with two actions of their choice, which they will describe in detail. These actions must significantly reduce the CO<sub>2</sub> emissions of an assigned country, taking into account the various constraints and criteria discussed in the lecture and during the project sessions. However, they will be assessed individually rather than collectively.

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|----------------------------------------------------------------------------------|--------------------------------------------------------------|---------------------------|
|  | <b>Energy policies, transitions and engineering projects</b> | <b>PGE1 S05 – UE ECD1</b> |
|                                                                                  |                                                              | 24/02/2026                |
|                                                                                  |                                                              | Page 2/2                  |

## Learning outcomes

[Bloom Taxonomy level] – scale from 1 to 6

- [2] Explain the context of global warming, strategic issues and current geopolitical issues
- [2] Identify solutions and levers that can reduce CO2 emissions and preserve biodiversity and resources, or improve environmental conditions from the perspective of future engineers (toolbox) – observations vs. developments
- [3] Combine the elements discussed and link this teaching to the 17 Sustainable Development Goals (SDGs)
- [3] Experiment with challenges in collaboration with teams and companies
- [3] Solve complex, interdependent problems and discover solutions

## Prerequisites

- Two years of higher education in science

## Learning material

- PNACC3 : Plan National d'Adaptation au Changement Climatique
- <https://www.agenda-2030.fr/17-objectifs-de-developpement-durable/>
- <https://www.un.org/fr/exhibit/odd-17-objectifs-pour-transformer-notre-monde>
- International Energy Agency; World Economy outlook, Country Profile
- IRENA; World Energy Transition outlook
- Banque Mondiale ; données.banquemondiale.org
- Element de géologie, 17<sup>e</sup> édition du Pomerol, Dunod, 2021
- L'ISO et le changement climatique.
- Rapports GIEC, AIE, IRENA.
- The Shift Project (2022), Former l'ingénieur du XXI<sup>ème</sup> siècle, Disponible sur : [https://theshiftproject.org/article/publication-rapport-former-ingenieur-du-21esiecle/150731\\_Charte\\_ethique.pdf](https://theshiftproject.org/article/publication-rapport-former-ingenieur-du-21esiecle/150731_Charte_ethique.pdf) (iesf.fr)

|      |                                              |                        |
|------|----------------------------------------------|------------------------|
| estp | <i>Challenges for cities and territories</i> | <b>PGE1 S5 UE ECD1</b> |
|      |                                              | 24/02/2026             |
|      |                                              | Page 1/2               |

**Teaching language: English**

**Number of hours: 10h**

Lectures:9h / Final assessment: 1h

### **Course description and assessment**

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This course aims to introduce future construction engineers to the major contemporary urban challenges through the lens of sociology. It focuses on understanding how social dynamics, uses, lifestyles, and territorial inequalities influence the design, management, and transformation of urban spaces. The course emphasizes sociological analysis methods applied to urban planning, development, housing, and public works, as well as the interdisciplinary collaboration essential for the success of urban projects.

#### **Introduction to Urban Sociology**

- Definition and role of sociology within the human sciences
- Sociology, urban planning, and spatial development: connections and key issues
- Major schools of urban sociology (Durkheim, Weber, Bourdieu, etc.)

#### **Sociological Methods Applied to Urban Planning**

- Quantitative approaches (statistics, surveys, mapping)
- Qualitative approaches (interviews, observations, participatory methods)
- Cross-analysis and interdisciplinary co-design

#### **Major Contemporary Urban Issues**

- Urban sprawl, peri-urbanization, and land artificialization
- Density, socio-spatial segregation, and territorial equity
- Mobility, infrastructure, and real estate markets

#### **Sociology and Construction Professions**

- Considering uses and users in project design
- Public consultation, citizen participation, and collective intelligence
- Case studies and practical examples (transport, housing, public spaces, etc.)

Assessment: Learning outcomes will be assessed through a final exam (multiple-choice questionnaire).

#### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, the engineering student will be able to:

- [1] Define the basic concepts of urban sociology and identify major urban issues
- [2] Explain the interactions between social dynamics and urban planning
- [3] Apply sociological research methods to urban planning challenges
- [3] Analyze an urban situation using sociological tools
- [3] Assess the relevance of participatory and interdisciplinary approaches in construction projects

#### **Prerequisites**

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- mathematics

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|----------------------------------------------------------------------------------|----------------------------------------------|------------------------|
|  | <i>Challenges for cities and territories</i> | <b>PGE1 S5 UE ECD1</b> |
|                                                                                  |                                              | 24/02/2026             |
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## Learning material

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- Hervé Marchal et Jean-Marc Stébé, La sociologie urbaine, collection Que sais-je ?, PUF, 2010 (ré-édition 2018)
- Michel Pinçon et Monique Pinçon-Charlot, Les Ghetto du Gotha, Le Seuil, 2007
- Eric Maurin, Le Ghetto français, enquête sur le séparatisme social, Seuil, 2004
- Jacques Donzelot (sous la direction de), A quoi sert la rénovation urbaine ?, PUF, 2012
- Anne Lambert, Tous propriétaires, L'envers du décor pavillonnaire, Le Seuil, 2015
- Eric Hamelin et Olivier Razemon, La tentation du Bitume, où s'arrêtera l'étalement urbain ?, Rue De l'Echiquier, 2012 (ré-édition 2020)

|                                                                                  |                                                                |                        |
|----------------------------------------------------------------------------------|----------------------------------------------------------------|------------------------|
|  | <b>Stakeholders and Challenges of the construction project</b> | <b>PGE1 S5 UE ECD1</b> |
|                                                                                  |                                                                | 24/02/2026             |
|                                                                                  |                                                                | Page 1/2               |

**Teaching language: English**

**Number of hours: 25,5h**

Lectures: 12h / Project: 12,5h / ODL (S: 1h) / Project evaluation: yes

### **Course description and assessment**

The Stakeholders and Challenges of the construction project course is part of the « Sustainable Construction Challenges » course in the first year. The course consists of several lectures on the following themes:

Lecture 1: Construction project: Issues, Players, Organisation & Standards:

- Knowledge of the act of building:
- Definition, Role, Missions, Obligations, Status, Mandatory or optional nature of the various construction Actors: Owner, Owner's Representative, Owner's Representative, BET, Control Office, SPS Coordinator, SSI, Contractors, etc.
- The stakes of the construction project: missions, responsibilities and risks of the various participants

Lecture 2:

a - Tools for representing an EPC project - Architect lecture 1

- The different phases of a project and the design process: Feasibility, ESQ, APS, AVP, PC, APD, DCE, PRO, VISA, ACT, EXE, OPC, AOR, DOE - Expected documents
- The organisation of the standards and regulations landscape in France (ERP, PMR, fire, etc.)

b- : Reuse and transformation of buildings in Paris - Architect lecture 2

Lecture 3 : History: Major periods through the works of major architects, pivotal works... Architects Conference 3

Lecture 4 : Principles of bioclimatic/sustainable design - Historical developments - Examples - Architects Conference 4

- EPC project : Analysis of an existing project based on a file showing the development of a construction project. Case study: Analysis of the programme, the structural layout, the schedule, etc., followed by a project to design part of the building: extension, raising or reallocation of part of the existing building (programming exercise, etc.).
- Design in teams of 4 or 5

In the case of conversion of structures :

- Project 1: Stakeholders and stakeholder diagrams, Critical Architectural Analysis.
- Project 2: Critical Architectural Analysis of a building & its integration into its environment.
- Project 3: Critical Architectural Analysis (continued): Highlighting a construction detail and the use of light,
- Project 4: Making proposals for a proposed transformation: Proposal for a programmatic diagram or sketch of the project's intention.
- Project 5: Oral presentation on the case study-project with a powerpoint and /or A3 file (and/or a model)

### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

- [3] Simultaneously combine expressed objectives, context, use, techniques and aesthetics.
- [5] Produce a representation of an invented project, mastering the notions of scale and spatiality.
- [5] Produce an architectural design with its various implications, putting yourself in the architect's shoes to understand the conceptual process and the constraints encountered.

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|----------------------------------------------------------------------------------|----------------------------------------------------------------|------------------------|
|  | <b>Stakeholders and Challenges of the construction project</b> | <b>PGE1 S5 UE ECD1</b> |
|                                                                                  |                                                                | 24/02/2026             |
|                                                                                  |                                                                | Page 2/2               |

### Prerequisites

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- None

### Learning material

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- RIZZOTTI P., *L'empreinte d'un habitat- Construire Léger et Décarboné*, 2022
- Conserver Adapter Transmettre, Pavillon de l'Arsenal, 2022
- LE CORBUSIER, *Le Modulor*, 1948
- COSSE L., *La grande Arche*,
- COHEN J L., *Architecture, Modernité, Modernization*, 2014
- Application Détour : <https://www.caue75.fr/detour>

European construction products regulation

|                                                                                  |                           |                 |
|----------------------------------------------------------------------------------|---------------------------|-----------------|
|  | <i>Business economics</i> | PGE1 S5 UE ECD1 |
|                                                                                  |                           | 24/02/2026      |
|                                                                                  |                           | Page 1/2        |

**Teaching language: English**

**Number of hours: 10h**

Lectures: 9h / Final assessment: 1h

### **Course description and assessment**

This course provides key insights into the functioning, organization, and environment of businesses, particularly within the construction and engineering sectors. It explores the diversity of business forms, their core functions, value creation, and the central role of the financial function in corporate strategy and performance.

#### **The Concept of a Company**

Objective: Understand what a company is, its roles, and its main functions.

- Definitions and roles of a company
  - What is a company?
  - Economic and social objectives
  - Company stakeholders
- Core business functions
  - Commercial and marketing function
  - Production and procurement function
  - Financial function and resource management
- Management and organizational function
  - Leadership and decision-making
  - Human resource management
  - Procurement and supplier relations

#### **Diagnostic Tools: Internal and External Analysis**

Objective: Identify a company's strengths, weaknesses, opportunities, and threats to better understand its positioning.

- Internal analysis
  - Key resources and capabilities
  - Analysis of strengths and weaknesses
  - Performance and adaptability
- External analysis
  - Analysis of the economic, social, and regulatory environment
  - Market opportunities and threats
  - Competitor and partner analysis
- Corporate strategy
  - Definition and strategic objectives
  - Strategic choices and positioning
  - Strategy and competitive advantage

#### **Business Structure**

Objective: Understand how a company is organized to operate efficiently.

- Key principles and structural characteristics
  - What is an organizational structure?
  - Centralization vs decentralization
  - Formalization of procedures
- Types of organizational structures
  - Functional structure
  - Divisional structure
  - Matrix structure and other hybrid forms
- Determinants of structure
  - Size and complexity of the company
  - External environment and constraints
  - Corporate strategy and culture
- Learning outcomes will be assessed through a final exam (multiple-choice questionnaire).

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|----------------------------------------------------------------------------------|---------------------------|------------------------|
|  | <i>Business economics</i> | <b>PGE1 S5 UE ECD1</b> |
|                                                                                  |                           | 24/02/2026             |
|                                                                                  |                           | Page 2/2               |

## Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of the course, the engineering student will be able to:

- [1] Define the fundamental concepts related to the company, its functions, and its stakeholders.
- [2] Explain the roles, economic and social purposes of the company, as well as value creation.
- [2] Describe the main organizational structures and their characteristics (functional, divisional, matrix, etc.).
- [3] Apply internal and external diagnostic tools to simple business examples.
- [4] Analyze a company's environment, strategy, and structure, and deduce their impacts on its organization and performance.
- [4] Compare the advantages and limitations of different business structures in various contexts.
- [5] Critically assess the alignment between a company's structure, strategy, environment, and objectives.

## Prerequisites

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- None

## Learning material

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- Nathalie CLARET, Bertrand SERGOT, Stratégie, Nathan Sup, 2012
- Richard WHITTINGTON, Patrick REGNER, Duncan ANGWIN, Gerry JOHNSON, Kevan SCHOLLES, Stratégique, 12ème édition, Pearson, 2020
- Henry MINTZBERG, Le management : Voyage au centre des organisations, Poche, Editions d'Organisation, 2004

|                                                                                  |                                           |                        |
|----------------------------------------------------------------------------------|-------------------------------------------|------------------------|
|  | <b>Mathematics : Analysis and Algebra</b> | <b>PGE1 S5 UE MOD1</b> |
|                                                                                  |                                           | 24/02/2026             |
|                                                                                  |                                           | Page 1/2               |

**Teaching language: English**

**Number of hours: 30h**

Lectures: 9h / ODL (As: 3h, S:1h ) / Tutorials: 15h / Final assessment: 2h

### Course description and assessment

This course, which is part of the core curriculum of the “**Mathematics: analysis and algebra**” teaching unit, aims to equip students with the mathematical methods and tools necessary for studying the basic scientific and technical disciplines of an engineer (structural mechanics, fluid mechanics, acoustics, signal processing, numerical analysis, technological disciplines, etc.).

The main concepts covered are:

- tensor calculation
  - ✓ Review of vector calculus and linear algebra
  - ✓ definition and basic properties of a tensor: multilinear application defined on a tensor product space
  - ✓ Introduction of tensor fields for the physical properties of a material
  - ✓ Application: Generalised Hooke's law  $\sigma = C\varepsilon$ 
    - $\sigma$  Second-order stress tensor
    - $\varepsilon$  Second-order strain tensor
    - $C$  Fourth-order elasticity/stiffness tensor
  - ✓ Covariant derivative (concept) for curved materials
- $L^p$  spaces
  - ✓ Definition of  $L^p$  spaces and norms
  - ✓ Definition and use of Hilbert bases
- Operations on functions
  - ✓ Review of differential equations and direct methods
  - ✓ Convolution product
  - ✓ Fourier transform
  - ✓ Fourier series
  - ✓ Laplace transform;
- distributions;
  - ✓ definition
    - Modelling of shock pulses and defects in materials
  - ✓ derivation of a distribution, jump formula
    - Application to differential equations, beam theory
- partial differential equations
  - ✓ concept of a 'well-posed problem'
  - ✓ classification (hyperbolic, elliptic, parabolic) and canonical form
  - ✓ solution: method of separation of variables
  - ✓ Difference between 'differential equations' and 'integral equations'

Assessment will be based on a final exam (2-hour written exam).

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of this course, engineering students will be able to:

- manipulate tensors
- master the mathematical tools used to solve physics equations (distributions, Fourier, Laplace);
- classify partial differential equations and solve them in a few simple configurations;
- master basic mathematical concepts for numerical simulation

|                                                                                  |                                           |                        |
|----------------------------------------------------------------------------------|-------------------------------------------|------------------------|
|  | <b>Mathematics : Analysis and Algebra</b> | <b>PGE1 S5 UE MOD1</b> |
|                                                                                  |                                           | 24/02/2026             |
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### Prerequisites

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- Mathematical analysis and algebra from the MP, PS and PSI scientific preparatory classes or mathematics/physics degree programme

### Learning material

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- A brief tensor analysis (Site université de Sharif)
  - W. Rudin, Analyse réelle et complexe, Cours et exercices, 3ième édition, ed. Dunod (1987) (un peu ardu mais très complet)
  - Stanford Engineering Everywhere – EE261 – The Fourier Transform and its applications
  - L. Gabet, Analyse. Polycopié de cours ECP 1ère année (2008/2009)
  - A. Rondepierre, A. Rouchon, Introduction aux dérivées partielles. Etude théorique, cours INSA Toulouse 2ième année IC, département STPI (2012-2013)
  - J.D. Logan, Applied Partial Differential Equations 3rd Edition, Springer (2015)
- D. Borthwick, Introduction to Partial Differential Equations, Springer (2016)

|                                                                                  |                                            |                        |
|----------------------------------------------------------------------------------|--------------------------------------------|------------------------|
|  | <b>Digital Programming - Data Analysis</b> | <b>PGE1 S5 UE MOD1</b> |
|                                                                                  |                                            | 24/02/2026             |
|                                                                                  |                                            | Page 1/1               |

**Teaching language: English**

**Number of hours: 15h**

Tutorials: 10h (4 x 2,5h) / Practical work: 5h (2 x 2,5h)

### Course description and assessment

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This core course in the "**Mathematics and Modelling**" Teaching Unit is for students in their first year at engineering schools and focuses on the scientific programming used to solve what are usually mathematical problems through use of digital algorithms optimised for modern computers. The Python language was chosen due to its relative simplicity, object orientation and wide use in computer science.

The main notions addressed are:

- Scientific calculation in Python with the NumPy library, SciPy, Pandas and graphic representation with the Matplotlib library,
- Application of various research and optimisation algorithms
- Managing Excel and data handling
- Web scraping: HTML parsing and web data collection.

### Assessment methods:

Assessment will be based on the average of Practical Work reports.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of the course, student engineers will be able to:

- Program with Python (Intermediate and Advanced levels) ;
- Use the main scientific computing libraries, including Numpy, SciPy, Pandas and Matplotlib;
- Perform data analysis;
- Formulate a concrete problem in computer terms;
- Apply algorithmic thinking to a scientific problem-solving approach;
- Retrieve data directly from the web.
- Pilot Excel from a python program and implement data analysis techniques using the full power of a spreadsheet;
- Acquire the rigor and critical thinking skills needed by engineers.

### Prerequisites

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- Knowledge of algorithmics
- Prior use of a programming language's syntax

### Learning material

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- Python Tutorial, <http://docs.python.org/3/tutorial/>
- *Apprendre à programmer avec Python*, Gérard Swinnen, Eyrolles (free pdf on internet, in french : [http://users.polytech.unice.fr/~helen/pythonCIP1/apprendre\\_python3Swinnen.pdf](http://users.polytech.unice.fr/~helen/pythonCIP1/apprendre_python3Swinnen.pdf))
- E-learning courses on e-campus for refresher courses (in french)

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|----------------------------------------------------------------------------------|--------------------------|-----------------------|
|  | <b>Materials Science</b> | <b>PGE1 S5 UE MM1</b> |
|                                                                                  |                          | 24/02/2026            |
|                                                                                  |                          | Page 1/1              |

**Teaching language: English**

**Number of hours: 16h**

Lectures: 7h / ODL (As: 2,5h) / Tutorials: 2,5h / Practical work: 3h / Final assessment: 1h

### Course description and assessment

This core course in the "**Mechanics and Materials**" Teaching Unit acts as an introduction to materials sciences. In general fashion, it addresses the main materials encountered in the fields of construction and industry. Its aim is to establish the links between the structure and properties of materials, and to understand the microscopic and macroscopic behaviour of materials under stress. Finally, the course aims to provide a basic understanding of the main characterisation techniques of materials. The main notions addressed are:

- General information on materials (history, cost, life cycle, material classes and chemical bonds),
- Crystal structure of materials (Bravais lattices, compactness, density, defects in crystals),
- Phase diagrams (definitions, two-phase equilibrium, three-phase equilibrium, iron/carbon diagram, obtaining diagrams),
- Physico/chemical, structural and mechanical characterisation of materials (X-ray diffraction, X-ray fluorescence, scanning electron microscopy, infrared spectroscopy, mechanical testing),
- Specific features of materials used in construction (metals and alloys, polymers, ceramics, composites, wood).

As a supplement to the courses, the practical work session on the mechanical characterisation of metal materials is designed to provide a practical illustration of the link between the material's microstructure and its mechanical properties. It also enables us to experimentally determine the values of the main characteristics of materials, in order to allow them to be optimally used in mechanical or metal constructions.

Three types of tests are proposed for this practical work;

- Tensile strength test
- Hardness test
- Resilience test.

### Assignments:

The module will be assessed on the basis of a final exam based on the five parts of the above-mentioned course (accounting for 2/3?) and a practical work report (accounting for 1/3?).

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of the course, student engineers will be able to:

- Be familiar with the various building materials and situate them in the field of engineering technologies;
- Be familiar with the main fields of application of classes of materials at an industrial scale.

### Prerequisites

- Have taken physics and chemistry courses during classes preparing for graduate school entrance, higher education certificate (DUT) or bachelor's degree levels.

### Learning material

- Michael F. Ashby, David R. H Jones. Matériaux. T1 Propriétés, applications et conception. Editions Dunod, 2013
- Michel Dequatremare, Thierry Devers. Précis des matériaux. Editions Dunod, 2012
- Michel Dupeux, Jacques Gerbaud. Exercices et problèmes de sciences des matériaux, Editions Dunod, 2010
- Michel Dupeux. Science des matériaux : aide-mémoire, Editions Dunod, 2008
- Jean Pierre Mercier, Gérald Zambelli, Wilfried Kurz. Introduction à la science des matériaux. PPUR presses polytechniques, 1999

|                                                                                  |                                           |                       |
|----------------------------------------------------------------------------------|-------------------------------------------|-----------------------|
|  | <b>Construction Materials Engineering</b> | <b>PGE1 S5 UE MM1</b> |
|                                                                                  |                                           | 24/02/2026            |
|                                                                                  |                                           | Page 1/1              |

**Teaching language: English**

**Number of hours: 27.5h**

Lectures: 7h / ODL (As: 2h) / Tutorials: 7,5h / Practical work: 9h / Final assessment: 2h

### Course description and assessment

This core course in the “**Mechanics and Materials**” Teaching Unit is a general introduction to construction materials. The main notions addressed are:

- **Chapter I** - Introduction to the physicochemical properties of civil engineering materials (concrete and bitumen)
- **Chapter II** – Aggregates: physicochemical and mechanical properties. Use in concrete and asphalt mixes.
- **Chapter III** - Hydraulic binders: Cement  
Manufacture, chemical composition and chemistry of cement. Hydration mechanism and evolution of physicochemical (porosity, microstructure, etc.) and mechanical properties.
- **Chapter IV** - Concrete materials: part 1, composition and properties.

The Construction Materials Engineering course comprises three practical works and three tutorials. The three practical works cover:

Practical work N°1: Specific surface area of cements and mortar properties.

Practical work N°2: Mortar rheology and standardized consistency.

Practical work N°3: Bitumen and bituminous mixes

### Assessment methods:

The module will be assessed on the basis of a final exam (weighting 3/5) and the average of the 3 practical works presentations (weighting 2/5).

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of the course, students will be able to:

- Know and master the properties of civil engineering materials: cements, mortars and bitumen
- Select materials based on their properties, applications and standards

### Prerequisites

- Physicochemical analysis methods. Characterization of mechanical properties of materials.

### Learning material

- *Nouveau guide du béton et de ses constituants*, Georges Dreux, Jean Festa – Eyrolles.
- *Caractérisation des pâtes de ciment et des bétons. Méthodes, Analyse, Interprétations*, Véronique Baroghel-Bouny
- *Mémento technique des granulats*, Richard Maillot – Presses Des Mines
- *Enrobés bitumineux : tome I*, USIRF/Routes de France – Éditions RGRA, 2001
- *Enrobés bitumineux : tome II*, USIRF/Routes de France – Éditions RGRA, 2003
- *NF EN197-5 : ciment – partie 5 : ciment Portland composé CEMII/C-M et ciment composé CEMVI*. Mai 2021

|                                                                                  |                            |                       |
|----------------------------------------------------------------------------------|----------------------------|-----------------------|
|  | <b>Vibration Mechanics</b> | <b>PGE1 S5 UE MM1</b> |
|                                                                                  |                            | 24/02/2026            |
|                                                                                  |                            | Page 1/2              |

**Teaching language: English**

**Number of hours: 22.5h**

Lectures: 6h / ODL (As: 3h, S: 1.5h) / Tutorials: 10h / Final assessment: 2h

### **Course description and assessment**

This core course in the 'Mechanics and Materials' teaching unit aims to teach students the scientific approach to physics with examples from the construction industry. The main concepts covered are:

- Vibrations of linear systems with 1 degree of freedom
- Vibrations of linear systems with 2 or more degrees of freedom
- Vibrations of continuous systems

The topics of damping and their representativeness will also be covered.

#### **Lecture 1: Vibration of single-degree-of-freedom systems**

Reminder of the formulation of equations without damping and with damping.

Free oscillations and forced oscillations, either harmonic or following an impulse signal (in the case of an impact).

Application to simple mechanical systems borrowed from the field of civil engineering and construction (vibration of beams and vibrations of portal structures).

Illustrations on topics relevant to design offices (vibrations of machines placed on floors)

Introduction to in-situ measurements (case studies of vibration measurements following a situation of vibration discomfort near a railway line).

#### **Lecture 2: Vibrations of systems with multiple degrees of freedom (with discretisation) and vibrations of continuous systems**

Formulation des équations pour des systèmes mécaniques à 2 degrés de liberté

Illustration au calcul d'élément de type TMD « Tuned Mass Damper » sur des bâtiments Immeubles de Grande Hauteur

Caractérisation de l'amortissement par des mesures in-situ

Illustration des mesures d'amortissement sur le cas d'un programme de recherche sur les immeubles de grande hauteur en bois

Formulation des équations pour des systèmes mécaniques continus et illustrations des modes propres pour des systèmes continus (focus sur structures poutres avec vibrations de flexion)

#### **Tutorial 1: Response of mechanical systems with 1 degree of freedom without damping**

Determination of forced vibration responses for portal and beam systems in the absence of damping.

The initial disturbance conditions of the system are taken in a differentiated manner (displacement, velocity at  $t=0$  and/or periodic force).

#### **Tutorial 2: Response of mechanical systems with 1 degree of freedom and damping**

Vibrational response of mechanical systems with damping.

Case studies based on real-life situations: Vibrations on industrial floor structures supporting production machinery (large printers on floors)

Example of excitation of a footbridge by pedestrians

|                                                                                  |                            |                       |
|----------------------------------------------------------------------------------|----------------------------|-----------------------|
|  | <b>Vibration Mechanics</b> | <b>PGE1 S5 UE MM1</b> |
|                                                                                  |                            | 24/02/2026            |
|                                                                                  |                            | Page 2/2              |

### **Tutorial 3: Response of mechanical systems with 2 degrees of freedom**

Vibrational response of mechanical systems with two degrees of freedom

Determination of natural modes and illustration of Rayleigh damping.

Example of structures damped by vibrational decoupling (case of vibrational isolation of buildings).

### **Tutorial 4: Response of mechanical systems with distributed mass**

Détermination des pulsations propres pour des systèmes à masse répartie ainsi que des modes propres

Comparaison avec d'autres types de discrétisation simplifiée (1 ou plusieurs masses)

Assessment will be based on a final exam (2 hours).

### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, engineering students will be able to:

- [3] Understand the mechanical vibration systems commonly encountered in the field of building structures or engineering structures;
- [4] Master simplified analytical calculations using rapid calculations to understand the risk of structural vibration;
- [3] Understand the phenomenon of damping;
- [3] Raise awareness among engineering students of the importance of vibration dynamics in structural design
- [3] Assess parameters and their uncertainty in the field of structural vibration. Understand the benefits of a combined experimental and analytical approach.

### **Prerequisites**

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- Admission to the ESTP competitive entrance exam or admission based on qualifications after a decision by the jury, or international knowledge of physics at the L2 level for students from English-speaking and French-speaking foreign universities.

### **Learning material**

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- *Mécanique Vibratoire des systèmes discrets linéaires*, Michel Del Pedro and Pierre Pahud
- *Engineering Vibration*, Daniel J. Inman
- *Mechanical vibrations*, S Graham Kelly, Schaum Outline editions

|                                                                                  |                            |                |
|----------------------------------------------------------------------------------|----------------------------|----------------|
|  | <i>Continuum Mechanics</i> | PGE1 S5 UE MM1 |
|                                                                                  |                            | 24/02/2026     |
|                                                                                  |                            | Page 1/2       |

**Teaching language: English**

**Number of hours: 33.5h**

Lectures: 7.5h / ODL (As: 3h, S: 3h) / Tutorials: 15h / Practical work: 3h / Final assessment: 2h

### Course description and assessment

The Continuum Mechanics course is part of the first-year 'Mechanics and Materials' module. The course aims to provide the theoretical foundations and operational tools for analysing linear deformation and Cauchy stress states in continuous media. Hooke's law is illustrated in order to provide students with the analytical tools necessary for understanding, in particular, the elastic behaviour of deformable materials. The course includes theoretical and practical sessions. The main topics covered are:

- Lecture 1 : Introduction/tensor calculation**  
 Concept of tensors (definition, second-order tensor, third-order tensor), examples of tensors (Kronecker delta symbol, permutation, Einstein summation), inverse of the tensor, definition of invariants, eigenvalues and eigenvectors, orthogonal tensor, index notation and Nabla operation.
- Tutorial 1 : tensor calculation, calculation of invariants, use of the index expression,
- Tutorial 2 : Exercise on the Nabla operator, calculation of the eigenvalue of a second-order tensor,
- Lecture 2 : the continuous medium/deformations and stresses**  
 Kinematics and motion: transformation gradient (Jacobian matrix), Lagrangian and Eulerian descriptions. Small deformation and deformation measurements.  
 Concept of stress and Cauchy stress: Equations of equilibrium and boundary conditions. Stress vector, normal and tangential stress, stress vector equilibrium, principal stress, Mohr's circle in 2D,
- Tutorial 3 : Lagrangian and Eulerian motion analysis, dual rotation vector tensor, rotation matrix, calculation of the deformation field
- Tutorial 4 : Cauchy stress tensor, calculation of the stress vector, calculation of principal stresses and principal directions, expression of deformation energy from the stress and deformation field
- Lecture 3 : linear elastic behaviour law/Hooke's law**  
 Expression of the equilibrium equation with Cauchy's stress field, deformation energy density, relationship between Cauchy's stresses and deformations—generalised Hooke's law, Hooke's law for isotropic materials, material parameters—Young's modulus, Poisson's ratio, Lamé coefficient, Navier-Stokes equation for solids.
- Tutorial 5 : Understanding Mohr's circle in 2D, and its application to calculate principal stresses and maximum shear stresses.
- Tutorial 6 : Establish equilibrium equations, apply the Navier-Stokes equation for solids to analyse a structure and calculate its tracked displacements.
- Tutorial 7 : Dealing with special cases – plane stress, plane strain, analysis of stress states beyond the elastic limit using Tresca and von Mises criteria.
- Practical work 1 : Mechanical testing at the RDM and Structure Laboratory** A three-hour practical session is scheduled towards the end of the theoretical course. Thanks to an approach combining numerical simulation (RDM6 & Solidworks/Ansys) and experimentation, students can highlight issues addressed in class and in tutorials. Students will carry out mechanical tests,

|                                                                                  |                            |                       |
|----------------------------------------------------------------------------------|----------------------------|-----------------------|
|  | <b>Continuum Mechanics</b> | <b>PGE1 S5 UE MM1</b> |
|                                                                                  |                            | 24/02/2026            |
|                                                                                  |                            | Page 2/2              |

including tensile and torsion tests, at the RDM and Structure Laboratory. In their report, they will be required to perform a theoretical calculation, which will be compared with the experimental and numerical simulation results.

The final assessment of the theoretical part will be based on a final exam.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, engineering students will be able to:

- analyse displacement and deformation fields based on kinematic relationships,
- evaluate stress states for isotropic materials and identify their main characteristics,
- apply stress and strain theory in the numerical modelling of isotropic and elastic materials, as well as in experimental testing.

### Prerequisites

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- Basic concepts of vector calculus (elementary operations, gradient, divergence, eigenvalues, etc.); calculation of simple derivatives and integrals; solution of ordinary differential equations with constant coefficients.
- Physics courses, mathematics courses at bachelor's degree level, DUT (university technical diploma) or preparatory school level.

### Learning material

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- J. Salençon, *Mécanique des milieux continus*, tomes I to III. Les Éditions de l'École Polytechnique, 2002
- P. Germain, P. Muller, *Introduction à la mécanique des milieux continus*, Masson, 1995
- F. Frey, *Analyse des structures et milieux continus - Mécanique des solides*, Traité de Génie civil de l'Ecole polytechnique fédérale de Lausanne (Volume 3), 2e édition, Presse Polytechniques and Universitaires Romandes, 2002

|                                                                                  |                                                     |                        |
|----------------------------------------------------------------------------------|-----------------------------------------------------|------------------------|
|  | <b>Technical Design of Structures and Eurocodes</b> | <b>PGE1 S5 UE STC1</b> |
|                                                                                  |                                                     | 24/02/2026             |
|                                                                                  |                                                     | Page 1/1               |

**Teaching language: English**

**Number of hours: 26,5h**

Lectures: 12h / Tutorials: 12,5h (5 sessions) / Final assessment: 2h

### **Course description and assessment**

The aim of this Building major course is to train engineers with sufficient theoretical knowledge of general construction techniques in order to allow them to obtain jobs easily, whether in project ownership, project management, contractors or technical inspection.

Lectures content:

- 3h: Design of Structures through Eurocodes - Fundamental principles, definition of actions and basis of dimensioning in Eurocodes
- 3h: Structural work terminology -- Building systems - Structural choices: On-site and off-site construction: walls, columns, beams, floors - Masonry construction
- 3h: Main structural elements of a building: Walls, Posts, Beams, Floors - Characteristics, Roles, Standards, Construction methods
- 3h: Foundation and support techniques

The case study will be based on a real project of reasonable size, and will cover the various sections below:

- 2,5h, Tutorial 1: Eurocodes: Find the right Resource documents: from the ESTP library access portal
- 2,5h, Tutorial 2: Descending loads - Study of the transfer of vertical and horizontal loads in a building
- 2,5h, Tutorial 3: Choice of structure: Load-bearing wall or column-beam systems
- 2,5h, Tutorial 4: Prefabrication in the building industry
- 2,5h, Tutorial 5: Pile calculation principle

### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of the course, students will be able to identify, name and describe the structural components of a building.

They will be proficient in the behaviour of structures: stability, vertical load distribution, bracing.

They will know how to choose the components and construction systems best suited to the project and its environment.

### **Prerequisites**

- None

### **Learning material**

- *NEUFERT* – Éditions Le Moniteur
- *La construction comment ça marche*, Le Moniteur, 2018
- *Memento Collection from Le Moniteur*
- *Videos from the "Agence Qualité de la Construction" website*

Eurocodes

- Legislative version: Website: Cobaz (AFNOR standards, NF, ISO, etc.)
- Explained version: Kheox website for regulations, standards, and their deciphering or Batipédia website (Regulatory and technical standards) via the ESTP library

|                                                                                  |                              |                        |
|----------------------------------------------------------------------------------|------------------------------|------------------------|
|  | <i>Planning and networks</i> | <b>PGE1 S5 UE STC1</b> |
|                                                                                  |                              | 24/02/2026             |
|                                                                                  |                              | Page 1/1               |

**Teaching language: English**

**Number of hours: 22h**

Lectures: 15h / Tutorials: 5h / Final assessment: 2h

**Course description and assessment**

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The Planning and Networks course is divided into 2 main parts:

**Part 1: Earthworks** (10.5h, 3 x 3.5h sessions)

- **Characteristics of various types of earthwork (cut and fill)**
  - ✓ Session 1: Road geometry (LP, CS, etc.)
- **Layout of earthwork platforms**
  - ✓ Session 1: Road layout (main features and regulations)
  - ✓ Session 1: Structures and roads (type section and structural operation)
- **Creation of an earthwork volume measurement table**
  - ✓ Session 2: Reminder of topography principles applied to roadworks
  - ✓ Session 2: Interpretation of a table of cubic contents
- **Earth movements between cut and fill areas**
  - ✓ Session 2: Principles of earthworks
  - ✓ Session 2: Environment and materials
- **Choice of earth-moving machinery and implementation of a complete project**
  - ✓ Session 3: Study of the GTR (Technical Guide to Creation of Embankments and Layers of Form) (4 chapters)

**Part 2: Roads and utilities** (10.5h, 3 x 3.5h sessions)

- Road creation techniques and methods
- Sanitation system creation techniques and methods
- Drinking water supply system creation techniques and methods
- Techniques and methods for creation of miscellaneous networks (utilities)

Assessment will be based on a final test mark.

**Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

---

At the end of the course, student engineers will be able to:

- [1] Examine the different characteristics of cut and fill, and earthwork platforms.
- [1] Create a volume measurement table.
- [5] Discuss the choice of earth-moving machinery depending on type of project
- [2] Decide on the right machinery for an excavation site
- [4] Design drinking water supply systems (collection, pipeline network, reservoirs, etc.)
- [4] Design sanitation systems (design, composition, calculation of stormwater and wastewater flows)
- [1] Identify other networks (electricity distribution, gas distribution, heating network, telecommunications, laying fibre optic cables) and their cohabitations
- [4] Adapt the safety rules required during location and use of networks and earthworks

**Prerequisites**

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- None

**Learning material**

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- Guide des terrassements routiers
- Manuels d'enseignements à distance « *Voirie et Réseaux divers* », de Adriana MIRI,
- Guides pratiques et Techniques de SETRA sur les V.R.D.,
- Mise en disposition des présentations des cours,
- Logiciel Geomensura

|                                                                                  |                       |                        |
|----------------------------------------------------------------------------------|-----------------------|------------------------|
|  | <b>Thermodynamics</b> | <b>PGE1 S5 UE STC1</b> |
|                                                                                  |                       | 24/02/2026             |
|                                                                                  |                       | Page 1/1               |

**Teaching language: English**

**Number of hours: 23h**

Lectures: 9h / ODL (As: 2h) / Tutorials: 10h / Final assessment: 2h

### **Course description and assessment**

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The applied thermodynamics course, a core course in the “Construction Sciences and Techniques” teaching unit, covers the main principles of energy.

- Lesson 1 : Thermodynamic quantities and units of measurement, Heat, Work, Internal energy, Enthalpy ; First principle for open and closed systems, First principle for ideal gases ; Second principle, entropy, refrigeration cycles and motors, Carnot cycle, efficiency and coefficient of performance, entropy, principle of increase, reversibility and irreversibility.
- TD1 : Application of the first and second principles
- Lesson 2 : Phase change : gases. Gibbs' rule, properties of saturated vapours. Psychrometric quantities ; transformations of humid air : simple heating, simple cooling, cooling and dehumidification, adiabatic humidification and humidification by introduction of vapour, adiabatic mixing. Air conditioning in an air treatment plant
- TD2 : Application of psychrometric quantities and transformations of humid air.
- TD3 : Application of air conditioning in an AHU, summer and winter cases.
- Lecture 3 : Energy and mass balances for calculating energy demand in a building, sensible and latent heat of the occupants, internal contributions from equipment, external conditions, ventilation and air infiltration.
- TD4 : application of energy and mass balances in a building ; determination of the temperature and flow rate of air blown in by a ventilation system.

The student engineer will be assessed by a final exam.

### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, the student engineer will be able to :

- Interpret the principles of applied thermodynamics, Carnot's motor and receiver cycles, and the sizing of the components of an air handling unit ;
- Analyse energy systems ;
- Apply energy and mass balances to calculate energy demand in buildings.

### **Prerequisites**

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- Engineering Mathematics 1

### **Learning material**

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- Yunus-A Cengel, Michael-A Boles : Thermodynamique - Une approche pragmatique
- Renaud Giquel : Systèmes énergétiques.: Tome 1. Méthodologie d'analyse, bases de thermodynamique, composants ; Transvalor - Presses des mines – 2009

|                                                                                  |                                     |                        |
|----------------------------------------------------------------------------------|-------------------------------------|------------------------|
|  | <b>Energy of Electrical Systems</b> | <b>PGE1 S5 UE STC1</b> |
|                                                                                  |                                     | 24/02/2026             |
|                                                                                  |                                     | Page 1/1               |

**Teaching language: English**

**Number of hours: 28h**

Lectures: 9h / ODL (As: 2.5h, S: 1h) / Tutorials: 5h / Practical work: 9h / Final assessment: 1.5h

### Course description and assessment

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The Electrical Systems Energy course, a core course in the 'Construction Science and Technology' teaching unit, covers the main principles of electricity and electrical engineering, the operating principles of transformers, electrical machines and renewable energy production systems:

- **Lecture 1** : Fundamental concepts (fundamental laws, alternating current, power measurement, iron core coil, etc.)
- **Practical work 1** : Single-phase/three-phase power measurement. (Characteristics, power balance)
- **Lecture 2** : Principle of electrical energy distribution (power transformers, usefulness in electrical networks)
- **Practical work 2** : Single-phase/three-phase power transformer. (Specifications, no-load, load and short-circuit testing, power balance)
- **Lecture 3** : Principles of electrical conversion (photovoltaic/wind generators, general information on machines, converters, power balances, etc.).
- **Practical work 3** : *Photovoltaic /wind turbine conversion chain/electrical machines* panels and systems. (Characteristics, power balance and sizing of a photovoltaic installation)

Engineering students will be assessed by means of a practical work mark and a final exam.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, engineering students will be able to:

- Describe the main principles of electricity and electrical engineering
- Understand the principle of power measurement
- Characterise a magnetic circuit
- Propose the appropriate electrical equipment
- Draw up electrical diagrams
- Analyse the various practical tests
- Calculate/dimension an electrical conversion system
- Master the operating principle of an electrical system.

### Prerequisites

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- Analysis and algebra

### Learning material

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*Principes d'électrotechnique* (Dunod)  
*Électrotechnique*, Théodore Wildi

|                                                                                  |                                       |                       |
|----------------------------------------------------------------------------------|---------------------------------------|-----------------------|
|  | <b>Leadership and Communication 1</b> | <b>PGE1 S5 UE SK1</b> |
|                                                                                  |                                       | 24/02/2026            |
|                                                                                  |                                       | Page 1/1              |

**Teaching language: English**

**Number of hours: 11.5h**

Lectures: 3h / Project: 5h / ODL (As: 1h) / Project assessment: 2.5h

### **Course description and assessment**

This course introduces students to self-reflection and self-promotion essential steps in building a coherent and impactful career plan.

Each student learns to: identify their strengths and areas for development, structure and write a CV, a cover letter, and a LinkedIn profile tailored to their career goals.

#### **Self-awareness and Highlighting One's Journey**

- Identify personal skills, values, and motivations
- Introduction to writing a CV, cover letter, and LinkedIn profile
- Understanding application standards and expectations (1st-year internship)

#### **Personal Project Development**

- Personalized CV writing and reflective analysis
- Writing a cover letter adapted to the targeted sector
- Developing and optimizing the LinkedIn profile (summary, experiences, skills)
- Refinements, peer reviews, and individual feedback

#### **E-Learning Path**

- Tutorials and resources on CV, cover letter, and LinkedIn writing
- Self-assessment quizzes

Assessment: Learning outcomes will be evaluated through a final project-based exam, consisting of a written report and an individual oral presentation.

#### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of the course, the engineering student will be able to:

#### **Knowledge:**

- [4] Master the fundamentals of professional written communication
- [1] Understand the norms and expectations of job interviews
- [1] Discover techniques for public speaking, both in-person and on camera (introductory level)

#### **Skills:**

- [3] Create or update their curriculum vitae and LinkedIn profile
- [3] Submit applications online via job boards or respond to internship/job offers
- [3] Write professional emails using a clear and effective style

#### **Prerequisites**

- None

#### **Learning material**

- Guyette Lyr, La mise en scène de soi, Editions d'organisation
- E. Marc et D. Picard, Relations et communications interpersonnelles, Dunod 2015

# ***Semester 6 – Course descriptions***



## English-taught Program semester 6

| Teaching Unit (UE) | S6 Curriculum / Spring semester                                         | Study hours per Teaching Unit (UE) | Study hours per course | ECTS credits | Weighting in the UE |
|--------------------|-------------------------------------------------------------------------|------------------------------------|------------------------|--------------|---------------------|
| <b>UE ECD2</b>     | <b>Management and Innovation</b>                                        | <b>62,00</b>                       |                        | <b>6</b>     |                     |
| UE ECD2            | General Accounting                                                      |                                    | 18,00                  |              | 1                   |
| UE ECD2            | Labor Law                                                               |                                    | 10,00                  |              | 1                   |
| UE ECD2            | Organisation of Construction Sites                                      |                                    | 20,00                  |              | 2                   |
| UE ECD2            | Occupational Health and Safety (OHS1)                                   |                                    | 8,00                   |              | 1                   |
| UE ECD2            | Design Thinking & Innovation                                            |                                    | 6,00                   |              | 1                   |
| <b>UE MOD2</b>     | <b>Mathematics and Modeling</b>                                         | <b>109,00</b>                      |                        | <b>7</b>     |                     |
| UE MOD2            | Digital Analysis                                                        |                                    | 28,50                  |              | 2                   |
| UE MOD2            | Digital Modeling Project                                                |                                    | 19,00                  |              | 1                   |
| UE MOD2            | Probability and Statistics                                              |                                    | 27,50                  |              | 2                   |
| UE MOD2            | Digital Signal Processing                                               |                                    | 15,00                  |              | 1                   |
| UE MOD2            | Parametric Modeling and BIM                                             |                                    | 19,00                  |              | 1                   |
| <b>UE MM2</b>      | <b>Mechanics and Materials</b>                                          | <b>85,00</b>                       |                        | <b>6</b>     |                     |
| UE MM2             | Fluid Mechanics and Hydraulics                                          |                                    | 30,50                  |              | 2                   |
| UE MM2             | Soil Mechanics                                                          |                                    | 26,00                  |              | 2                   |
| UE MM2             | Performance of Concrete Materials                                       |                                    | 13,00                  |              | 1                   |
| UE MM2             | Introduction to Research (project)                                      |                                    | 15,50                  |              | 1                   |
| <b>UE STC2</b>     | <b>Construction Sciences and Techniques</b>                             | <b>102,00</b>                      |                        | <b>7</b>     |                     |
| UE STC2            | Strength of Materials                                                   |                                    | 38,00                  |              | 2                   |
| UE STC2            | Heat transfer                                                           |                                    | 11,50                  |              | 1                   |
| UE STC2            | Urban Topometry                                                         |                                    | 22,00                  |              | 2                   |
| UE STC2            | Production, transmission and distribution of electrical energy          |                                    | 22,00                  |              | 1                   |
| UE STC2            | Road Innovation                                                         |                                    | 8,50                   |              | 1                   |
| <b>UE SK2</b>      | <b>Communication and Professional Project</b>                           | <b>47,00</b>                       |                        | <b>4</b>     |                     |
| UE SK2             | Leadership & Communication 1                                            |                                    | 14,00                  |              | 2                   |
| UE SK2             | ESTP Professional Conferences                                           |                                    | 3,00                   |              | 0                   |
| UE SK2             | English                                                                 |                                    | 30,00                  |              | 2                   |
|                    | <i>French as a Foreign Language (international students) - optional</i> |                                    | 30,00                  |              |                     |
|                    | <i>Main Foreign Language (German or Spanish) - optional</i>             |                                    | 30,00                  |              |                     |
|                    | <i>Additional Foreign Language - optional</i>                           |                                    | 16,50                  |              |                     |
|                    |                                                                         | <b>405,00</b>                      |                        | <b>30</b>    |                     |

**Teaching language: English**

**Number of hours: 17.5h**

Lectures: 9h/ Tutorials: 7.5h/ Final assessment: 1h

### **Course description and assessment**

The General and Analytical Accounting course, part of the Management and Innovation unit, offers a progressive and contextualized approach tailored to the specific challenges of companies in the construction sector.

Students will learn the fundamental principles of accounting, the organization of company accounts, the reading and analysis of financial statements, as well as the use of management (analytical) accounting. Special attention is given to cost management, VAT, fixed assets, and profitability calculation methods applied to the construction sector.

#### **General Accounting Fundamentals**

- Objectives and principles of accounting
- Organization of company accounts
- Financial statements (balance sheet, income statement, appendix)

#### **Accounting Operations Specific to the Construction Sector**

- VAT and its specific features in the construction industry
- Fixed assets and depreciation
- Introduction to accounting information analysis

#### **Analytical Accounting and Cost Management**

- Introduction to management (analytical) accounting
- Treatment of direct and indirect costs in construction projects
- Inventory management and cost calculation methods (full cost, variable cost, break-even point) applied to construction

**Assessment:** Learning outcomes will be assessed through a final written test (multiple-choice exam).

#### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of this course, engineering students will be able to:

- [2] Explain corporate strategy and its environment within the construction sector.
- [2] Describe the general mechanisms of financial and management accounting applied to construction.
- [3] Apply management accounting as a decision-making tool in site management.
- [3] Calculate cost price and analytical results for a construction project.
- [3] Prepare a detailed quotation and profitability study adapted to the specificities of the sector.
- [3] Analyze and interpret key financial statements to assess the financial performance of a project.

#### **Prerequisites**

- Business economics

### **Learning material**

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- Caroline SELMER, La boîte à outils de la finance d'entreprise, 4ème édition, éditions Dunod, 2023
- Béatrice et Francis GRANDGUILLLOT, Comptabilité générale, 22ème édition, Collection mémentos Apprendre utile, Editions Gualino, 2022/2023

**Teaching language: English**

**Number of hours: 10h**

Lectures:9h / Final assessment: 1h

### **Course description and assessment**

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The *Labor Law* course, part of the *Management and Innovation* unit, introduces the main aspects of social legislation through the “life cycle” of the employment contract.

#### **Introduction to Labor Law**

- The hierarchy of norms
- Recruitment and hiring
- Types of employment contracts

#### **Individual Employment Relationship**

- The employment contract
- Specific clauses of the employment contract

#### **Collective Employment Relations**

- Employee representative bodies and social dialogue
- The special status of protected employees

#### **Employee Support and Development**

- Employee development
- Disciplinary law

#### **Termination of Employment Contracts and Related Issues**

- Types of contract termination
- Dismissal of protected employees
- Equality, discrimination, and harassment

**Assessment:** Learning outcomes will be assessed through a final written exam (multiple-choice test).

#### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of the course, students will be able to:

- [1] Describe the legal rules governing different types of employment contracts,
- [2] Explain the employment contract life cycle and its termination,
- [4] Analyze professional equality, discrimination, and workplace harassment.

#### **Prerequisites**

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- None

## Learning material

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### Ouvrages de référence :

- Jean-Emmanuel Ray, Droit du travail (Dalloz, dernière édition)
- Françoise Favennec-Héry, Droit du travail (Gualino, dernière édition)

### Ressources en ligne :

- Site officiel Légifrance
- Fiches pratiques du Ministère du Travail

### Articles et revues :

- Revue Droit Social (Dalloz)
- Revue Lexbase

**Teaching Language: English**

**Total hours: 20h**

Lectures: 10h-Project: 10h, Assessment project: Yes

### Course description and assignments

The objective of the course is to provide the first keys to understanding how a construction site operates and how a construction project begins. Topics covered:

- The necessary formalities for starting construction work (Posting, standard documents, etc.)
- The main stages of site installation
- The sizing of the 3Ms (Human resources, Equipment, Materials)
- The composition of a site team and the characteristics of the productive workforce (categories, skills, selection, cost)
- The preparation of different types of schedules (Gantt chart, Railway diagram, etc.)
- The parameters for sizing a construction site installation – Concepts of site logistics
- The characteristics, selection, and required authorizations for lifting equipment
- The characteristics and selection of safety equipment
- The regulatory documents required during the site installation phase
- The methods of communication and monitoring on the construction site

The assessment will be based on a project (real case) including:

- The definition of workforce requirements & the sizing of the Living Base
- The creation of a schedule using software
- The creation of a Production Inventory Control (PIC)

### Learning outcomes

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [1] Identify the construction methods
- [2] Determine the human resources required
- [3] Decide on the operating methods,
- [1] Identify and prioritize tasks
- [3] Select a lifting device and justify its characteristics
- [3] Design a Site Installation Plan (SIP)
- [1] Identify the administrative documents required before the opening of a construction site
- [1] Apply safety regulations

### Prerequisites

- The course Construction Actors - Terminology (S05)

ESTP

*Non-contractual document - May change*

- The Occupational Health and Safety 1 course – (course in the same semester to be taken in parallel)<sup>1</sup> - <sup>2</sup>

## **Learning material**

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Ressources de la bibliothèque de l'ESTP :

- Mise en disposition des présentations projetées lors de soutenances des cours,
- (Mise à disposition des corrigés des travaux pratiques réalisés).
- Utilisation du décret du 8 janvier 1965 et des Conventions Collectives des salariés du BTP.
- Utilisation des logiciels Revit et Openproj MicrosoftProject, et/ou autre logiciel de planification.

**Teaching language: English**

**Total hours: 7h**

Lectures:4,5 / E-Learning: 1h30 / Final assessment:1h

### **Course description and assessment**

**This first module on Occupational Health and Safety will address construction site hazards:**

An introductory lecture will present how the online module works, provide information on the regulatory framework, accident statistics in France and internationally by sector and specifically in the construction industry, raise awareness of the importance of prevention, and emphasize the appropriate attitude to adopt regarding risks. the role of safety officer will also be presented, as well as the necessary qualifications, particularly in electrical safety.

Content of the OPPBTP (e-learning) module:

#### **I.Work Analysis:**

- 1.1. Understanding OPPBTP and the tools available.
- 1.2. Learning the concept of the Damage Occurrence Mechanism.
- 1.3. Introduction to the concepts of risk perception and assessment.
- 1.4. Presentation of Serious and Imminent Danger: Duty to raise the alarm and right to withdraw.

#### **II.General Principles of Prevention:**

- 2.1. Understanding the general principles of prevention and their regulatory origins.
- 2.2. Applying a decision-making logic based on the general principles of prevention.

#### **III.Risk Assessment:**

- 3.1. Identification of the Single Risk Assessment Document (DUER) and its action plan.
- 3.2. Analysis of construction site risks: inherent, imported, and exported risks.

The engineering student will be assessed through continuous assessment via e-learning by the OPPBTP (50%) and a final evaluation (50%), consisting, for example, of a multiple-choice questionnaire (MCQ) with analytical questions and the option to include graphic documents for half the grade, and a short synthesis of the learning outcomes for the other half.

This module is complemented, depending on operational opportunities at each campus where the PGE program is offered, by additional training and prevention activities related to occupational health and safety (such as workshops proposed by the Passion BTP association and/or conferences, etc.).

### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

**At the end of this course, the engineering student will be able to:**

- [3]** Apply the duty to raise the alarm or the right to withdraw from a situation when necessary.
- [2]** Define key reflexes and be able to explain them in order to detect hazardous situations and implement appropriate solutions.

[2] Identify the human, social, economic, and legal stakes of Occupational Health and Safety (OHS) within the company by observing health-related aspects in the workplace, referring to applicable regulatory and normative frameworks, and communicating with both internal and external prevention stakeholders.

[3] Integrate OHS into activity management and project leadership by identifying existing and potential hazards and dangerous work situations, assessing the risks of accidents and health issues, and eliminating or reducing those risks.

[2] Understand prevention-related terminology, articulate their future role in workplace prevention, and assess how prevention practices have evolved in the construction industry.

### Learning material

- e-campus : online modules
- <https://www.preventionbtp.fr>
- INRS - Aide-mémoire BTP Edition 790 (fournis aux élèves sous format électronique), support de cours.

**Teaching language: English**

**Total hours: 6h**

Project: 6h

### Course description and assessment

The Design Thinking & Innovation project, part of the Management and Innovation unit, introduces engineering students to an innovation methodology originating from California. Inspired by the mindset of designers. This approach emphasizes action, practical implementation, and rapid testing of ideas, with the aim of delivering maximum value to users.

The module encourages teamwork, creativity, and learning by doing. Students work on innovative solutions in the construction sector and present their results in a final oral defense before a jury.

- **Chapters**
- **Introduction and Awareness**
  - Lecture on Design Thinking
  - Presentation of the challenge
- **Creativity Workshops**
  - Workshop launch
  - Ideation sessions
- **Preparation and Prototyping**
  - Development and structuring of innovative solutions
  - Pitch preparation
- **Communication and Presentation**
  - Pitch rehearsal

- Oral defense before a jury
- Awards and closing
- **Assessment:** Final oral presentation (pitch) before a jury.

## Learning outcomes

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At the end of the project, students will be able to:

- [2] Describe the principles and key stages of the Design Thinking approach,
- [3] Use ideation methods to develop innovative solutions,
- [4] Analyze user needs to design an adapted response,
- [5] Collaborate in a team to design, structure, and formalize a solution,
- [6] Pitch an innovative solution effectively before a jury.

## Prerequisites

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- None

## Bibliography and further resources

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- L'esprit du Design Thinking, Michael Lewrick
- Le Design Thinking au service de l'innovation responsable, Xavier Pavie

**Teaching Language: English**

**Total hours:** 26 h

Lectures: 9 h ; Tutorials: 10 h / Lab : 5h ; Assessment: 2h)

### **Course description and assignments**

Numerical analysis, a core course of the teaching unit "Mathematics and Modeling," is a cross-disciplinary field between engineering sciences, mathematics, and computer science. It models physical problems in order to translate them into mathematical equations that will be solved numerically through computing. This course covers the following concepts:

- Polynomial approximation,
- Numerical integration,
- Matrix numerical analysis,
- Numerical solution of differential equations,
- Numerical solution of partial differential equations.

The assessment will be based on a final exam and the average of the lab report grades.

### **Learning outcomes :**

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [1] Cite the basic methods of numerical analysis and choose the method to implement based on the modeled phenomenon. Justify this choice.
- [3] Produce mathematical solution schemes with a good estimation of error
- [3] Apply numerical methods and implement them in computational software (Python or MATLAB)
- [4] Analyze representative algorithms for computer-based numerical solving of scientific or technical problems
- [4] Analyze, test, and evaluate the results of a numerical computation

### **Prerequisites**

- The mathematics courses in preparatory classes and the courses on digital programming and data analysis.

### **Learning material**

- Analyse numérique matricielle, Luca Amodei, Jean-Pierre Dedieu, Coll. ScienceSup, Dunod

- Introduction à l'analyse numérique, Jacques Rappaz, Marco Picasso, PPUR (avec MOOC)
- Introduction à l'analyse numérique et matricielle et à l'optimisation, Philippe G. Ciarlet Coll. ScienceSup, Dunod

**Teaching Language: English**

**Total hours:** 16.5 h

Lectures: 1,5h – Project :15 h

### Course description and assignments

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The digital project falls within the framework of the "Mathematics and Modeling" course unit for first-year students. It allows ESTP engineering students to get acquainted with numerical modeling through a project related to the construction field and by using programming software. The result of the modeling will be presented both orally and in writing, all within a group dynamic.

The main topics covered are:

- Technological watch and technological advances in a given field
- The mathematical formulation of physical phenomena
- The modeling of physical phenomena using a numerical method
- The numerical implementation and variation of parameters.

The evaluation will be based on a project presentation in a work subgroup.

### Learning outcomes:

*[Bloom Taxonomy Level] – scale from 1 to 6*

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At the end of this course, the engineering student will be able to:

- [3] Use basic numerical analysis methods to model a physical phenomenon
- [4] Analyze the physical phenomenon
- [3] Develop algorithms to model the analyzed physical phenomenon
- [3] Produce professional deliverables (oral presentation, video, PowerPoint, poster, written report)
- [3] Develop learning and adaptability skills to solve problems
- [3] Foster group dynamics while developing personal skills
- [4] Analyze the quality and relevance of the work performed or of the proposed scientific approach

### Prerequisites

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- Basic knowledge in materials science, solid mechanics, numerical programming, and mathematics at the bachelor's degree, DUT, or preparatory school level.
- Mathematics courses at Bachelor's, DUT, or preparatory school level.
- Numerical analysis courses.

- Teaching for the 5th semester.

### **Learning Material**

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- Ressources bibliothèque ESTP et ressources W.

**Teaching Language : English**

**Total hours : 27,5 h**

Lectures : 12 h ; ODL : 1 h ; Tutorials: 12,5 h; Assessment: 2 h

### Course description and assignments

This course is part of the teaching unit "Mathematics and Modeling" and is divided into two parts. The first part, "Probability," studies the modeling of random variables, and the second part, "Statistics," allows for the modeling of random situations. The main concepts covered are:

- Review of axiomatic concepts (Compound probabilities, total probabilities, Bayes' theorem, Introduction to stochastic processes ;
- Random variables (discrete, continuous, one-dimensional and multidimensional)
- Presentation of fundamental laws and conditional laws, and independence of random variables
- Functions of random variables and representative parameters of random variables
- Normal distribution
- Content and purpose of statistics
- Issues and challenges in statistics
- Statistical estimation
- Techniques for constructing point estimators

The evaluation will be based on a final exam.

### Learning outcomes:

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- To explain the distribution of a discrete and continuous random variable;
- To recognize the fundamental distributions and use their properties (excluding the normal distribution);
- To calculate marginal distributions and verify the independence between two random variables
- To apply the image measure theorem
- To calculate a conditional expectation and apply the law of total expectation
- To calculate covariance and the correlation coefficient for a pair of random variables
- To use the properties of the normal distribution and its characteristic function
- To use the cumulative distribution function of the standard normal distribution
- To determine the distribution of the sample mean
- To master the applications and limitations of statistics
- To perform point estimation, interval estimation (confidence interval), and parametric (or non-parametric) statistical testing

### Prerequisites

- Level in mathematics consistent with what can be expected at the end of preparatory classes for grandes écoles and Bachelor's degrees.

### Learning material

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- Cours de probabilités (en ligne) – Sylvie Meleard – Ecole Polytechnique
- *Exercices de probabilités et statistiques* – J.P. Rowenczyk et Thérèse Phan – Dunod
- Exercices de probabilités (en ligne) – Benjamin Jourdain– École Nationale des Ponts et Chaussées

**Teaching Language: English**

Total hours: 15h

Lectures: 3h; ODL asynchronous: 1h ; ODL: 1h ; Lab: 10 h

**Course description and assignments**

This course is part of the teaching unit "Mathematics and Modeling" and deals with the science that analyzes and interprets the information contained in a signal. Given the vast number of signals that need to be processed, often in real-time, it becomes essential for engineers, across all fields, to master both the characterization of a signal in the time and frequency domains, the encoding of the signal, as well as the methods for developing mathematical models that will then be used in the numerical modeling of the signal. The student will be able to model the evolution of signal values over time in order to interpret signals and extract the maximum amount of useful information from a signal.

The main concepts covered are:

- The different types of signals and their classification
- Concepts of using the software employed
- Spectral analysis and Fourier analysis
- The frequency representation of a signal
- Signal digitization
- Signal filtering
- Signal sampling

The evaluation will be based on the grade of the lab reports.

**Learning outcomes:**

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [2] Recognize the different types of signals
- [3] Explain the characteristics of a signal (spectrum, filtering, digitization)
- [3] Use some digital signal processing techniques
- [3] Use software to perform signal processing.

**Prerequisites**

- Integral calculus.
- Proficiency with computer tools.
- Handling of complex numbers.

**Learning material**

- Lab work handout.
- Course handout.
- Guy Binet:
- *Traitement numérique du signal - Signaux et systèmes discrets*. Ellipses, 2013

**Teaching language: English**

**Total hours:** 21,5h

Lectures: 1,30h – Project: 20h

### Course description and assignments

Parametric project modeling and BIM is a core module of the course unit 'Mathematics and Modeling'. It allows students to become familiar with digital developments in the construction sector by presenting BIM as a collaborative working tool for designing models that integrate data.

The main concepts covered in this course are:

- Introduction to BIM and
- Modeling principles;
- Data management of the digital model;
- Getting started with the REVIT digital tool (levels, modeling of the building envelope, floors, walls, columns/beams...);
- Principles of sections, cut views, and stairs;
- Project georeferencing;
- Parametric modeling of a family and integration into the project;
- Render preparation and formatting.

The evaluation will be based on a group project.

### Learning outcomes:

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- To model a building and integrate it into its site;
- To understand the principle of georeferencing;
- To use the main modeling functions of REVIT;
- To perform an import/export of information related to REVIT objects;
- To work in a group on a BIM project using the collaborative BIM360 platform;
- To produce, from a 3D model, a list of deliverables such as section drawings and bill of materials tables.

### Prerequisites

- Knowledge of the stages of a construction project and the architectural & structural elements of a building.

## Learning material

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- Internet resources
- Resources from ESTP library

**Teaching language: English**

**Total hours:** 27,5 h

Lectures: 12 h; ODL asynchronous 1h ; ODL: 1,5h; Tutorials: 5 h ; Lab: 6 h – Assessment: 2 h

### Course description and assignments

Fluid mechanics is a science that falls under the teaching unit «**Mechanics and Structures**» and allows students to acquire fundamental knowledge about the characterization of fluids and the solving of fluid flow equations. The main concepts covered are:

- The mechanics of incompressible fluids
- Applied hydraulics.

The assessment will be based on a final exam and the average of the lab reports.

### Learning outcomes:

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- Know how to characterize a fluid / hydrokinematics (Lagrangian and Eulerian approaches, streamline, trajectory, velocity, acceleration (particle derivative)) ;
- Understand the fundamental principles of fluid mechanics:
  - ✓ Mass conservation;
  - ✓ Momentum conservation (Navier–Stokes equations and their variants: Euler, etc.).
- Be able to make assumptions about the flow to simplify the equation solving process (incompressible, irrotational, steady flow, etc.);
- Know the dimensionless numbers used to characterize a fluid (Reynolds number:  $Re$ , Froude number:  $Fr$ , etc.);
- Understand the different flow regimes: laminar and turbulent; and know how to characterize them;
- Be able to characterize pipe flows (Bernoulli's equation, definition of hydraulic head, linear head losses (Colebrook, Manning–Strickler) and singular losses, hydraulic machines (pumps and turbines));
- For open channel flows:
  - ✓ Understand the impact of bed roughness and bathymetry (bed mapping) on velocity and water depth;
  - ✓ Know the different flow regimes: subcritical and supercritical; and know how to characterize them (comparison between normal and critical depths, Froude number, etc.).

### Prerequisites

- Basic knowledge of mathematics and physics usually acquired in preparatory classes.

### Learning materials

ESTP

- 
- Access to various course materials on the E-campus platform, PPT presentation.

**Teaching language: English**

**Total hours: 25,5 h**

Lectures: 9h – ODL: 1h – Tutorials: 7,5h – Lab: 6 h – ECT: 2h

### Course description and assignments

This core course, part of the teaching unit «**Mechanics and Materials**» is designed to provide engineering students with the fundamentals related to soil identification, water flow in soils, as well as the study of their mechanical behavior. The main concepts taught are:

- The identification and classification of soils (formation, origin, structure);
- The characterization of soils in the laboratory and in situ and its relationship with their classification;
- The nature and definition of investigations for soil exploration;
- Elements of groundwater hydraulics (piezometer, aquifers, concept of capillarity);
- Flow in soils (Darcy's law, permeability and its measurement, solving problems of water flow in soils);
- Stresses in soils and the concepts of total stress and effective stress

The evaluation will be based on a final exam.

### Learning outcomes:

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- Master soil classification tools,
- Conduct soil characterization tests
- Determine the compaction characteristics of soils,
- Solve flow problems in soils.
- Calculate the total and effective vertical stresses.

### Prerequisites

- Course on strength of materials

### Learning material

- Éléments de mécanique des sols – François Schlosser ; Presses de l'école nationale des Ponts et Chaussées, 1997

- Théorie et pratique de la géotechnique – Claude Plumelle – Editions Le Moniteur, 2017
- Fondations et ouvrages en terre – Manuel professionnel de géotechnique du BTP - B. Hubert, B. Philipponnat, O. Payant et M. Zerhouni ; Editions Eyrolles, 2019.

**Teaching Language : English**

**Total Hours: 13h**

Lecture: 6 h – Tutorials: 2,5h - Lab: 3h - ECT: 1,5h

### Course description and assignments

This core course from the teaching unit "Mechanics and Materials" is a continuation of the "Construction Materials Engineering" course from S05 and provides an in-depth study of the concrete material. The main concepts covered are:

- **Chapter I** – Properties of concrete and formulation concepts.
- **Chapter II** – Implementation and curing of concrete.
- **Chapter III** – Volumetric deformations of concrete.
- **Chapter IV** – The NF 206 standard and environmental classes.
- **Chapter V** – Introduction to the durability of concrete.
- **Chapter VI** – Concrete at the heart of the ecological transition (through a lecture by the EFB).

The Concrete Performance course includes both a tutorial (TD) and a practical session (TP). The laboratory session focuses on the air content of mortar and the monitoring of hydration (kinetics and products) using the Powers model.

### Evaluation methods:

The module will be assessed based on a final exam covering the course sections mentioned above (weight 2/3?) and a practical assignment submission (weight 1/3?).

### Learning Outcomes

At the end of this course, the student will be able to:

- Know and master the properties of concrete in both its fresh and hardened states
- Master the concrete mix design criteria in relation to environmental classes
- Be familiar with new binders with low environmental impact

### Prerequisites

- Mastery of the physico-chemical and mechanical properties of hydraulic binders (cements)
- The main standardized tests
- The nomenclature of cements and new cements.

## Learning Material

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- *Nouveau guide du béton et de ses constituants*, Georges Dreux, Jean Festa - Eyrolles.
- *La durabilité des bétons*. (ENPC)
- *Ecostructure en béton* par Aïtcin Pierre-Claude
- *Construire en béton* par De Larrard François  
Course materials, Standards, Lab manual, Tutorial documents

**Teaching language: English**

**Total hours:** 38h

Lectures: 12h – Tutorials: 15h - Lab : 6h - ODL : 1h- ODL asynchronous: 2h – Assessment: 2h

### **Course description and assignments**

The course on Strength of Materials is part of the first-year curriculum of the UE « Sciences and Construction Techniques. » Its content focuses on the study of the deformation of solids, particularly deformable materials, subjected to various external loads. The fundamental objective of this course is to understand and master how these materials respond to applied forces such as tension, compression, torsion, and bending. By analyzing the reactions of materials and structures to these forces, the course aims to predict their deformation and assess their stability. In other words, it is about acquiring the necessary knowledge to anticipate how materials and structures respond under stress, which is crucial for the effective design and construction of buildings and structures.

Through the RDM course, the main concepts are covered in 4 sections:

#### **Lecture 1: Introduction**

Presentation of a torsor, static equilibrium, analysis of external forces, different types of supports, characteristics of straight sections—calculation of static moment, moment of inertia, center of gravity, radius of gyration, variation of inertia,

#### **Lecture 2: Main theories of Strength of materials**

RDM hypotheses - Euler-Bernoulli principle, Saint Venant principle, supports and reactions, calculation of the hyperstatic degree of structures, calculation of loads and determination of their diagrams (cutting method).

- Tutorial 1: calculation of internal forces in straight beams
- Tutorial 2: : calculation of internal forces in frames

#### **Lecture 3: Beam theory**

Analyses des sollicitations, calcul des contraintes internes (contrainte normale et cisaillement) et le cas de portique (isostatique),

- Tutorial 3 : calculation of normal stresses (section characteristic)
- Tutorial 4 : calculation of shear stresses (section characteristic)

#### **Lecture 4: Beam displacement**

BRESSE formulas; calculation of a deflection and the angle of rotation, and energy method (Castigliano's theorem)

- TD5 : Bresse Equation
- TD6 : Energy methods (Castigliano)

Two 3-hour lab sessions are scheduled at the 'Strength of Materials and Structures' laboratory. Through an approach combining numerical simulation (RDM6 & Solidworks) and experimentation, students can highlight issues discussed in lectures and tutorials. The various machines in the laboratory allow students to conduct mechanical tests on beam bending and stress analysis. In their report, a theoretical calculation is required, which must be compared with the experimental and numerical simulation results.

### Lab 1: Bending test on a beam

### Lab 2: Analysis of the constraints of a part under mechanical loads (photoelasticity)

The evaluation will be based on a final exam (3/5) and the grade of the practical reports (2/5)

### Learning outcomes

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- Calculate the geometric characteristics of the sections
- Calculate the degree of hyperstaticity of the structures
- Explain the different types of loads
- Establish diagrams of internal forces
- Calculate internal stresses in beams
- Calculate displacements and angles of rotation in beams

### Prerequisites

It is essential to recall certain key concepts such as stress and strain, linear elastic behavior laws, Hooke's law, force equilibrium, and strain energy density that were covered during the Continuum Mechanics course. A summary of these concepts is available in the form of a video capsule, thus providing students with a solid foundation before the "Strength of Materials" course.

### Learning material

ESTP

- [1] Aide-mémoire - résistance des matériaux - 10e éd. Jean Goulet, Jean-Pierre Boutin, Frédéric Lerouge, 352 pages, Editeur : Dunod, 2019
- [2] Calcul des ouvrages -Résistance des matériaux et fondements du calcul des structures, Erick Ringot - Collection Blanche BTP, 508 pages, Editeur : Eyrolles ,2017
- [3] Résistance des matériaux, André Bazergui, Thang Bui-Quoc, André Biron, Georges McIntyre, Charles Laberge, 730 pages, Editeur : Presse internationales polytechniques, 2003
- [4] The strength of Materials- a text-book for engineers and architects, Ewart S. Andrew, 638 pages, D. Van Nostrand Company, Twenty-five park place, 1916, (disponible en ligne)
- [5] Strength of Materials and Structures, Johan Case, Lord Chilver of cranfield, Carl T.F. Ross, 719 pages, ARNOLD, 1999, (available online)

**Teaching language: English**

**Total Hours: 12.5 h**

Lectures: 9h; Tutorials: 2,5h; Assessment: 1h

### Course description and assessment

The heat transfer course, a core course of the teaching unit 'Construction Science and Technology,' addresses the modes of heat transfer.

- **Lecture 1** : Thermal conduction and convection, Heat equation, Temperature and heat flux distribution, Fourier's law and Newton's law, Conductive and convective thermal resistance and Electrical analogy.
- **Lecture 2** : Thermal radiation of black and real bodies, Planck's Law, Wien's Law, Stefan-Boltzmann Law, Kirchhoff's Law. Implementation of an application on thermal radiation to determine the emissivity of a black body and another application to determine the thermal losses for a building composed of an opaque and transparent envelope.
- **Lecture 3** : Radiative exchange between surfaces, Form factor, Relationship between form factors, Net exchanged flux, Radiative thermal resistance and Electrical analogy, Radiative shield.
- **Tutorial 1**: Study of heat transfersApplication of conduction and thermal convection phenomena for the assessment of energy losses of a building with an opaque and transparent envelope. Implementation of thermal radiation for determining the emissivity of a blackbody, as well as for calculating radiative exchanges between different surfaces.

The engineering student will be assessed through a final exam.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- Identify the parameters defining the thermo-energy performance of opaque and transparent envelope components.
- Solve problems of heat transfer under steady-state conditions, determine the thermal losses of a building, and calculate radiative exchanges between multiple surfaces.

### Perquisites

- Engineering Mathematics 1

## Learning Material

- e-learning course
- Transferts thermiques – introduction – Dunod - [Jean Taine](#), [Franck Enguehard](#), [Estelle Iacona](#)

## Teaching Language: English

**Total Hours:** 22h

Lectures: 6h ; Lab: 16h

## Course description and assignments

At the intersection of geographical sciences, this course will allow the engineering student to discover the world of geographic information, as well as the responsibility of the surveyor in a construction project. Practically, this course will also make it possible to understand the different stages of drafting a topographic map, starting with the acquisition of conventional surveying observations. This course covers the following concepts:

- Terrestrial and space geodesy (GPS),
- Methods of representing the Earth's surface,
- Cartographic projection systems,
- General topometry:
  - Measurement of altitudes, angles, and distances: instruments and methods,
  - Calculation of planimetric and altimetric coordinates.
- Layouts.

The assessment will be based on a summary of the lab grades.

## Learning outcomes:

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will have acquired the following skills:

- [4] Identify the application of topography to professional needs;
- [5] Know how to use topographic instruments;
- [3] Apply spatial trigonometry concepts to a complex urban environment;

- [4] Reproduce existing conditions in their three-dimensional components;
- [3] Evaluate the quality of observations and calculation results;
- [4] Understand and integrate new technologies in geographic data acquisition processes (augmented reality, laser scanning, drones, etc.);
- [4] Collaborate effectively in a team to collect the information necessary for drafting topographic maps.

### Prerequisites

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- Preparatory class and first-year school courses in the following areas: spatial trigonometry, Mathematics and Physics, mastery of written expression and the scientific method.

### Learning material

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- *Cours de topométrie*, Serge Botton, ENSG
- *Maîtriser la topographie : des observations au plan*, Michel Brabant
- *Topographie et topométrie modernes*, Serges Milles, Jean Lagofun
- Lecture notes and lab manuals from ESTP

**Teaching Language: English**

**Total Hours:** 22 h

Lectures : 9h ; Tutorials : 5h ; Lab : 6h; Assessment: 2h

### Course description and assignments

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The course “Production, Transportation and Distribution of Electrical Energy,” part of the “Construction Science and Technology” teaching unit, covers the main principles of electrical energy generation, distribution, and storage.

- Lecture 1 → Electric Power Generation. Topics covered:
  - Basic concepts of electric power generation, including nuclear and renewable sources;
  - Methods for calculating production costs.
- Tutorial 1 → Application exercises focus on energy production systems.
- Lab 1 → The lab session allows students to simulate an energy production chain coupled with a storage system.
- Lecture 2 → *Electric Power Transmission*. Topics covered:
  - Architecture of the European transmission network;
  - Interconnections within the European transmission grid;
  - Modeling of a transmission line ( $\pi$ -model);
  - Calculation of power flows (Newton–Raphson method);
  - Voltage collapse (P–V curve method).
- Lab 2 → The lab session simulates a power generation plant connected to a transmission network. This network supplies a distribution grid where the energy is consumed. Students observe Joule losses as well as phase shifts caused by conductor imperfections.
- Lecture 3 → *Electric Power Distribution*. Topics covered:
  - Architecture of the French distribution network;
  - Current imbalance (complex number method);
  - Voltage imbalance (symmetrical component method).

Tutorial 2 → Application exercises cover the modeling of a transmission line (admittance matrix), synchronization of generated voltage for connection to the transmission network, and the definition of different types of network nodes.

→ Additional exercises address current imbalance, emphasizing the importance of balancing the grid when connecting new consumers. For voltage imbalance, they illustrate the electrical phenomena that occur and must be avoided to maintain network safety.

The engineering student will be assessed based on a lab grade and a final exam.

**Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

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- Interpret a schematic diagram of an electric power generation station;
- Identify the constraints related to energy transmission;
- Describe electrical distribution systems;
- Determine the type of electrical energy storage;
- Calculate losses.
- Numerically model a system containing a production station, transport lines, and the storage part

**Prerequisites**

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- Engineering Mathematics 1
- Energy of Electrical Systems
- Signal Processing

**Learning Material**

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- [1] Électrotechnique de Gilbert Sybille (Auteur), Théodore Wildi (Auteur). 2005
- [2] Réseaux électrique Technique de l'ingénieur
- [3] Le réseau électrique dans son intégralité Pieter Schavemaker (auteur), Emmanuel Hoang (traduction),

**Teaching Language: English**

Total hours: 8h (including one full day)

Lecture: 3h ; Asynchronous ODL: 1h of videos + associated activities not included; Synchronous online learning: 1 hour 30 minutes; Project presentation: 2 hours 30 minutes.

**Course Description and Assignments**

The overall goal of this module is to introduce the student to the concepts of innovation, using the field of road infrastructure as a basis. The module consists of face-to-face sessions (initially presenting the module and at mid-course the concepts of innovation illustrated with concrete examples) and an asynchronous pathway composed of different sequences:

- Discovery of road-related professions and the role of innovation in each of these professions, illustrated with concrete testimonies;
- The commitments of the road industry with a simplified presentation of the 2021 Engagement Pact, illustrated with examples.
- The differences between Research and Innovation, illustrated with testimonies from researchers in different sectors;
- The different types of innovations illustrated with concrete road innovation examples;
- Presentation of innovation techniques and processes;
- Multidisciplinary collaborative work, with an illustration from the road sector.

The asynchronous course includes parallel activities designed to check students' viewing and attention during these self-paced sessions (open-ended questions, quizzes, document analysis, etc.).

An independent group project of 7-8 students is initiated mid-course and presented during the lecture session. It takes place over 5 weeks and consists of conducting documentary research, synthesis, and reflection on an innovation topic using the resources and knowledge gained from the ROAD INNOVATION module.

Assessment is carried out through a presentation by each team, showcasing their project with the support of a 180-second video, in front of a jury, during a dedicated day (or half-day depending on the campus and number of teams) for the subject.

**Learning outcomes:**

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [4] Have knowledge of professions related to road infrastructure and their involvement in innovation;
- [3] Understand the collective commitments of the road industry to contribute to innovation topics;
- [3] Classify (according to its type) and analyze (according to TRL and BRL processes) an innovation;
- [3] Position research activities in relation to innovation;
- [4] Identify multidisciplinary resources in an innovation project;
- [4] Work as a team on a project and present it collectively.

### Prerequisites

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- None

### Learning Material

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- Video clips produced by the Pedagogical Innovation team on the channel [2021 - 2022 | Road Innovation \(ESTP Paris/ Routes de France\) - ESTP Paris | la WebTV \(ubicast.tv\)](#)
- Project journal
- Course materials

**Teaching language: English**

**Number of hours: 14h**

Lectures: 3h/ Project: 10h / ODL (As: 1h)

### Course description and assessment

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This course, part of the core curriculum within the “**Communication and Professional Development**” unit, develops interpersonal communication skills and prepares students for job interviews (internship search during Year 1).

- Introduction to interpersonal communication.
  - Fundamentals of active listening and reformulation.
  - Non-verbal communication and stress management.
  - Adapting speech to the interlocutor.
  - Preparing for an interview: identifying expectations and showcasing oneself.
  - Techniques to handle difficult questions (STAR method, tricky questions).
  - Debrief and introduction to the project.
- 
- The assessment of learning outcomes will be carried out during a project (Report + Presentation)

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of the course, the student will be able to:

ESTP

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- [3] Identify the fundamentals of interpersonal communication.
- [4] Apply active listening and reformulation techniques.
- [4] Adapt speech and posture to a professional interview.
- [5] Answer difficult questions in a structured manner.

### **Prerequisites**

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- Leadership & Communication – 1

### **Learning material**

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- Trouver le bon job grâce aux réseaux, Hervé Bommelaer, éditions Eyrolles, 2020
- Les premiers entretiens de recrutement, Peggy-Raffy-Hideux, éditions Ellipses, 2020
- Le défi des soft skills – J.Lamri, M. Barabel, O. Meier, T. Lubart, éditions Dunod, 2022

# ***Semester 7 – Course descriptions***

## English-taught Program - Semester 7

| Teaching Unit (UE) | S7 Curriculum / Fall semester                                           | Study hours per Teaching Unit (UE) | Study hours per course | ECTS credits | Weighting in the UE |
|--------------------|-------------------------------------------------------------------------|------------------------------------|------------------------|--------------|---------------------|
| <b>UE ECD2</b>     | <b>Sustainable Construction Challenges</b>                              | <b>82,00</b>                       |                        | <b>5</b>     |                     |
| UE ECD3            | Introduction to Urban and Environmental Legislation                     |                                    | 13,00                  |              | 1                   |
| UE ECD3            | Principles of Environmental Regulation (RE2020)                         |                                    | 20,50                  |              | 1                   |
| UE ECD3            | Engineering and Research Project 1                                      |                                    | 35,00                  |              | 2                   |
| UE ECD3            | Smart cities: principles and challenges                                 |                                    | 13,50                  |              | 1                   |
| <b>UE MOD3</b>     | <b>Mathematics and Modeling</b>                                         | <b>99,00</b>                       |                        | <b>8</b>     |                     |
| UE MOD3            | Finite element method (FEM): simulation tools                           |                                    | 21,50                  |              | 2                   |
| UE MOD3            | Introduction to Geographic Information Systems GIS/MIS                  |                                    | 26,50                  |              | 2                   |
| UE MOD3            | Digital tools for collaborative projects (BIM)                          |                                    | 12,50                  |              | 1                   |
| UE MOD3            | Climate engineering                                                     |                                    | 21,00                  |              | 2                   |
| UE MOD3            | Life cycle analysis (ACL) of a structure: method and tools              |                                    | 17,50                  |              | 1                   |
| <b>UE MGT1</b>     | <b>Project Management and Business</b>                                  | <b>55,00</b>                       |                        | <b>4</b>     |                     |
| UE MGT1            | Cost Accounting                                                         |                                    | 15,50                  |              | 1                   |
| UE MGT1            | Price studies                                                           |                                    | 10,50                  |              | 1                   |
| UE MGT1            | Project Management                                                      |                                    | 14,00                  |              | 1                   |
| UE MGT1            | Business game                                                           |                                    | 15,00                  |              | 1                   |
| <b>UE STC3</b>     | <b>Construction Sciences and Techniques</b>                             | <b>117,00</b>                      |                        | <b>9</b>     |                     |
| UE STC3            | Geotechnics                                                             |                                    | 25,00                  |              | 2                   |
| UE STC3            | Reinforced concrete                                                     |                                    | 25,00                  |              | 2                   |
| UE STC3            | Prestressed concrete                                                    |                                    | 15,00                  |              | 1                   |
| UE STC3            | Steel construction and other structures                                 |                                    | 23,50                  |              | 2                   |
| UE STC3            | Construction site technology                                            |                                    | 13,00                  |              | 1                   |
| UE STC3            | Acoustics                                                               |                                    | 15,50                  |              | 1                   |
| <b>UE SK3</b>      | <b>Communication and Professional Project</b>                           | <b>37,00</b>                       |                        | <b>4</b>     |                     |
| UE SK3             | Leadership & Communication 3                                            |                                    | 11,50                  |              | 1                   |
| UE SK3             | ESTP Professional Conferences                                           |                                    | 3,00                   |              |                     |
| UE SK3             | Internship report (end of 1st year)                                     |                                    | 0,00                   |              | 1                   |
| UE SK3             | English                                                                 |                                    | 22,50                  |              | 2                   |
|                    | <i>French as a Foreign Language (international students) - optional</i> |                                    | 30,00                  |              |                     |
|                    | <i>Main Foreign Language (German or Spanish) - optional</i>             |                                    | 30,00                  |              |                     |
|                    | <i>Additional Foreign Language - optional</i>                           |                                    | 16,50                  |              |                     |
|                    |                                                                         | <b>390,00</b>                      |                        | <b>30</b>    |                     |

|                                                                                  |                                             |                             |
|----------------------------------------------------------------------------------|---------------------------------------------|-----------------------------|
|  | <b>Urban planning and environmental law</b> | <b>PGE - S07 – UE ECD 3</b> |
|                                                                                  |                                             | 24/02/2026                  |
|                                                                                  |                                             | Page 1/1                    |

**Teaching language: English**

**Number of hours: 13.5h**

Lectures: 12h / Final assessment: 1.5h

### Course description and assessment

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#### Urban Planning Law

This core course, part of the "Sustainable Construction Issues" teaching unit, covers the legal frameworks and institutions established in France to ensure land development aligns with national spatial planning objectives.

#### Course Content

- Introduction to civil law: contract law and property law
- Territorial planning frameworks in urban development
- Urban planning regulations
- Urban planning documents and permits
- Urban development operations (e.g., ZAC, GOU, urban planning partnership contracts)
- Land use control (building and development permits, etc.)
- Environmental law (impact assessments and management of natural and technological risks)

Assessment: Learning outcomes will be evaluated through a final exam.

#### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of the course, the student will be able to:

- [3] Apply key concepts of urban planning law
- [2] Describe the general and specific rules for each step and procedure
- [3] Use the full set of regulations related to land use and spatial planning
- [2] Define preliminary control procedures and identify buildability data

#### Prerequisites

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- Employment Law

#### Learning material

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- Urbanisme et construction - Memento Pratique – 2019
- Droit de l'urbanisme – Pierre Soler COUTEAUX – 2022
- Le moniteur

|                                                                                  |                                                                       |                             |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------|
|  | <b>Principles and developments in environmental regulation RE2020</b> | <b>PGE - S07 – UE ECD 3</b> |
|                                                                                  |                                                                       | 24/02/2026                  |
|                                                                                  |                                                                       | Page 1/3                    |

**Teaching language: English**

**Number of hours: 20,5h**

Lectures: 12h/ Tutorials: 7.5h/ Final assessment: 1h

### **Course description and assessment**

The course on Principles and Developments in Environmental Regulations (RE2020) in the 'Sustainable Construction Issues' teaching unit aims to introduce the fundamental concepts and basic methods of building thermal engineering, with an emphasis on current thermal regulations:

#### **CM1: Introduction to building thermal engineering**

- Concepts, heat transfer by conduction, convection and radiation, building energy balance, calculation of heat loss;

#### **TD1: Heat loss calculation exercises**

- Application of heat transfer concepts to practical cases in individual housing
- Use of energy balances to assess heat loss in a building

#### **CM2: Principles of environmental regulations**

- Thermal and environmental regulations in France (importance of RT2012; E+C- label, principle of RE2020: objectives and requirements of the regulations);
- Energy and environmental interpretation of results (TH-BCE calculation methods, certified simulation tools, case studies)

#### **TD 2: Regulatory calculation exercises for an individual building**

- For a specific case of an individual dwelling, calculation of Bbio, DH and Cep objectives
- Based on a life cycle analysis, calculation of environmental objectives
- Interpretation of results and recommendations for improving energy performance

#### **CM3/4: Changes in environmental regulations**

At the same time, RE2020 introduces increasingly strict carbon emission thresholds, which are gradually being applied depending on the type of building:

- In 2025: First reduction in carbon emission thresholds for new buildings: encouragement of the use of bio-sourced materials
- In 2028: Further reduction in thresholds, with stricter energy and environmental performance requirements: obligation to integrate at least 50% bio-sourced materials into new buildings; - In 2031: Final stage with even stricter thresholds, aimed at aligning new construction with carbon neutrality targets: bio-based materials must become the majority of new construction.
- Knowing how to redirect the project if targets are not met: use of bio-based materials, innovative systems, and architectural designs.

### Tutorial 3: Exercises on case study analysis.

- Presentation of a case study of an existing building that complies with regulations.
- Analysis and interpretation of concrete cases according to current thermal regulations.

At the same time, RE2020 introduces increasingly strict carbon emission thresholds, which are gradually applicable depending on the building type:

- In 2025: First reduction in carbon emission thresholds for new buildings: encouragement of the use of bio-based materials.
- In 2028: further reduction of thresholds, with stricter energy and environmental performance requirements: mandatory integration of at least 50% bio-sourced materials in new construction;
- In 2031: final stage with even stricter thresholds, aimed at aligning new construction with carbon neutrality objectives: bio-sourced materials will have to become the majority in new construction.

Engineering students will be assessed using a final exam grade

| ENVIRONMENT |                                                     |                   |                                       |                    |
|-------------|-----------------------------------------------------|-------------------|---------------------------------------|--------------------|
| Year        | Building type                                       |                   | Functional Unit                       |                    |
|             | Detached or semi-detached houses (Single Family SF) | Multi-family (MF) | SF houses results                     | MF housing results |
|             |                                                     |                   | kg e.CO <sub>2</sub> /sm <sup>2</sup> |                    |
| 2022        | SF                                                  | MF                | 640                                   | 740                |
| 2025        |                                                     |                   | 530                                   | 650                |
| 2028        |                                                     |                   | 475                                   | 580                |
| 2031        |                                                     |                   | 415                                   | 490                |

| ENERGY |                                                     |                                                                 |                                       |                    |
|--------|-----------------------------------------------------|-----------------------------------------------------------------|---------------------------------------|--------------------|
| Year   | Building type                                       |                                                                 | Functional Unit                       |                    |
|        | Detached or semi-detached houses (Single Family SF) | Collective housing - CH (connected to an urban heating network) | SF houses results                     | MF housing results |
|        |                                                     |                                                                 | kg e.CO <sub>2</sub> /sm <sup>2</sup> |                    |
| 2022   | SF                                                  | CH                                                              | 160                                   | 560                |
| 2025   |                                                     |                                                                 | 160                                   | 320                |
| 2028   |                                                     |                                                                 | 160                                   | 260                |
| —      |                                                     |                                                                 | —                                     | —                  |

### Learning outcomes

[Bloom Taxonomy level] – scale from 1 to 6

At the end of this course, the engineering student will be able to:

- [2] Introduce the fundamental concepts of building thermal energy;
- [2] Master the aspects relating to the thermal regulations in force in France and the changes in the RE2020 requirements;
- [3] Explain in detail the regulatory calculation process and the objectives to be achieved in terms of building energy performance;

### Prerequisites

- Engineering Mathematics 1 & 2
- Applied Thermodynamics
- Heat Transfer

### Learning material

- CEREMA, Règlementation environnementale des bâtiments neufs (RE2020)
- [www.architectes.org](http://www.architectes.org)
- [www.cae-groupe.com](http://www.cae-groupe.com)

|                                                                                  |                                           |                             |
|----------------------------------------------------------------------------------|-------------------------------------------|-----------------------------|
|  | <b>Engineering and research project 1</b> | <b>PGE - S07 – UE ECD 3</b> |
|                                                                                  |                                           | 24/02/2026                  |
|                                                                                  |                                           | Page 1/2                    |

**Language of instruction: English**

**Number of hours: 35 h**

### Course description and assessment

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The Engineering and Research project is a project spanning semesters S7 (35 hours) and S8 (60 hours). Students will work in groups of 4 on a project throughout the academic year. They choose a topic from a list proposed by the teacher-researchers and academic and/or industrial partners. A wide range of subjects may be addressed, from experimental research to applied problems. During semester 7, as part of the Engineering and Research Project 1, the engineering students will be expected to:

- Analyze an issue based on specifications;
- Conduct a state-of-the-art review based on a scientific literature review;
- Develop a research protocol or an engineering project approach ;
- Produce scientific deliverables.

At the end of the semester, students begin to implement their methodology. They carry out experiments, calculations, simulations, and modeling according to the chosen topics, with a view to continuing the project in the 8th semester. Each group defends their work during an oral presentation, which will be graded. They are also assessed based on the deliverables produced for the project: the literature review report, the research protocol or project approach, and the presentation materials.

### Learning outcomes

*[Level in Bloom's taxonomy] – scale from 1 to 6*

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At the end of this course, the engineering student should have mastered:

- [4] principles of literature research and bibliography writing to establish the state of the art;
- [4] principles of scientific integrity; ;
- [4] methods for designing and implementing a scientific research protocol or an engineering project approach;
- [5] fundamentals of project management to carry out their work (time management, meeting management, etc.);
- [4] methods for studying the technical and economic feasibility of the project to justify the chosen approach;
- [4] rules of scientific writing to enhance their work: deliverables ;
- [5] rules of scientific presentation in a team: oral defense and reasoning of choices when responding to jury questions.

### Prerequisites

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- Completed the module "Introduction to Scientific Research in Semester 6";
- Work in a team to implement a project approach;
- Have an analytical and innovative mindset ;
- Have a critical mind and the ability to deduce;
- Demonstrate scientific curiosity.

|                                                                                  |                                           |                             |
|----------------------------------------------------------------------------------|-------------------------------------------|-----------------------------|
|  | <b>Engineering and research project 1</b> | <b>PGE - S07 – UE ECD 3</b> |
|                                                                                  |                                           | 24/02/2026                  |
|                                                                                  |                                           | Page 2/2                    |

## Learning material

Access to the documentary resources of the ESTP libraries:

- Scientific journals in print and digital formats,,Reference scientific books.
- Presentation documents,
- Project specifications,
- Course materials available on Ecampus,
- HAL,
- ArXiv,

On the theme of scientific integrity:

- Witkowski N. Trop belles pour le Nobel: les femmes et la science. Paris: Éd. du Seuil; 2007. (Points).
- Chevassus-au-Louis N. Malscience: de la fraude dans les labos. Paris: Éditions du Seuil; 2016. 199 p. (Science ouverte).
- Rothen F. Les combats de la science: racisme, créationnisme, spécisme, pensée magique 500 ans de lutte contre l'obscurantisme. Lausanne: EPFL Press; 2022.
- Guglielmi GJ, Koubi G. Le plagiat de la recherche scientifique. Paris: LGDJ-Lextenso éd; 2012.
- Broad W, Wade N, Broad W. La souris truquée: enquête sur la fraude scientifique. Paris: Éd. du Seuil; 1994. 320 p. (Points Sciences).
- Pracontal M de. L'imposture scientifique en dix leçons. Édition mise à jour. Paris: Éditions du Seuil; 2005.
- Cetro R, Sini L. Fake news, rumeurs, intox: stratégies et visées discursives de la désinformation. Paris: l'Harmattan; 2020. (Humanités numériques).
- Décret n° 2021-1572 du 3 décembre 2021 relatif au respect des exigences de l'intégrité scientifique par les établissements publics contribuant au service public de la recherche et les fondations reconnues d'utilité publique ayant pour activité principale la recherche publique - Légifrance [Internet]. [cité 26 janv 2024]. Disponible sur: <https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000044411360>
- ALLEA. Code de Conduite Européen pour l'Intégrité Scientifique: publication de l'édition 2023 [Internet]. 2023 [cité 26 janv 2024]. Disponible sur: <https://www.ofis-france.fr/edition-revisee-2023-du-code-de-conduite-europeen-pour-lintegrite-scientifique/>
- Article L335-2 - Code de la propriété intellectuelle - Légifrance [Internet]. [cité 26 janv 2024]. Disponible sur: [https://www.legifrance.gouv.fr/codes/article\\_lc/LEGIARTI000032655082](https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000032655082)
- Sur le thème de l'éthique de la science :
  - Arendt H, Kohn J, Fidel JL. Responsabilité et jugement. Paris: Éd. Payot & Rivages; 2009. (Petite Bibliothèque Payot).
  - Jonas H. Pour une éthique du futur. Paris: Editions Payot & Rivages; 2008.
  - Serres M. Petite poucette. Paris: Le Pommier; 2012. 82 p. (Manifestes).
  - Serres M. Morales espiègles. Paris: Le Pommier; 2019. 91 p. (Manifeste).
  - Kahn A, Lafay D. L'éthique dans tous ses états: dialogue avec Denis Lafay. La Tour-d'Aigues: Éditions de l'Aube; 2019. (Le monde en soi).
  - Marzano MM. L'éthique appliquée. 3e éd. Paris: Que sais-je ?; 2018. (Que sais-je ?).
  - Sur le thème de la méthodologie de la science :
  - Lichtfouse É. Rédiger pour être publié ! conseils pratiques pour les scientifiques. 2e éd. Paris Berlin Heidelberg [etc.]: Springer; 2011.
  - Hess R, Mutuale A, Crépeau B. Pratiquer le journal de recherche. Lyon: Chronique sociale; 2021. (Savoir communiquer).
  - Latour B, Biezunski M, Latour B. La science en action: introduction à la sociologie des sciences. Paris: Découverte / Poche; 2010. 663 p. (Sciences humaines et sociales).

- Leonelli S. La recherche scientifique à l'ère des Big Data: cinq façons dont les Big Data nuisent à la science, et comment la sauver. Milan (Italie) [Paris: Éditions Mimésis; 2019. (Philosophie).
- Olivier L, Bédard G, Ferron J. L'élaboration d'une problématique de recherche: sources, outils et méthode. Paris: L'Harmattan; 2005. 94 p. (Logiques sociales).
- Lindsay D, Poindron P. Guide de rédaction scientifique: l'hypothèse, clé de voûte de l'article scientifique. Versailles: Éd. Quae; 2011.
- Forget-Dubois N. Écrire un article scientifique en anglais: guide de rédaction dans la langue de Darwin. Laval (Québec) [Paris]: PUL, Presses de l'Université Laval diffusion Hermann; 2016.
- Pansu P, Dubois N, Beauvois JL. Dis-moi qui te cite, et je saurai ce que tu vauds: que mesure vraiment la bibliométrie ? Grenoble: Presses universitaires de Grenoble; 2013. (Points de vue & débats scientifiques).
- Pochet B. Comprendre et maîtriser la littérature scientifique. Gembloux: Les Presses agronomiques de Gembloux; 2015.

|                                                                                  |                                              |                      |
|----------------------------------------------------------------------------------|----------------------------------------------|----------------------|
|  | <i>Smart city : principes and challenges</i> | PGE - S07 – UE ECD 3 |
|                                                                                  |                                              | 24/02/2026           |
|                                                                                  |                                              | Page 1/2             |

**Teaching language :** English

**Number of hours :** 13.5h

Lecturers: 3h/ Tutorials: 5h / Practical: 3h / ODL: 1h / Final assessment: 1.5h

### Course and description assessment

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The smart city : principles and challenges the course « Challenges of sustainable construction » addresses the concept of the smart city, also know as « smart city », with a particular focus on the governance and management of smart cities, as well as the collection and processing of urban data. In addition, it explores the use of data in the context of smart mobility, while presenting the application of this concept in the field of buildings and energy, both at the local level (building) and at the global, level (urban networks and services).

- L1 – Smart City: Concept, Governance, Urban Data: This course is divided into four parts.
  - ✓ The first part explores the concept of the smart city, its implementation, and the associated challenges (risks, governance, empowerment of residents, etc.).
  - ✓ The second part focuses on the necessary technologies, including sensors and the Internet of Things (IoT) for data collection, communication networks and connectivity such as 5G, Wi-Fi and LoRa, as well as data and information management systems in the context of the rational use of technology.
  - ✓ The third part examines smart urban services, including urban planning, the implementation of a CMMS, the use of modelling and simulation for the design of sustainable neighbourhoods, and the integration of nature into the city through elements such as urban parks and green roofs.
  - ✓ Finally, the fourth part addresses security and personal data protection in the context of the smart city.
- L2 – Connected Buildings and Energy Efficiency : this course is structured in three parts.
  - ✓ The first part explores connected buildings, with an emphasis on the integration of advanced technologies to optimise resource use and improve occupant comfort.
  - ✓ The second part focuses on energy, particularly smart grids, which use advanced communication and control systems to optimise electricity distribution and integrate renewable energy sources.
  - ✓ Finally, the third part examines smart mobility, exploring the integration of electric and autonomous vehicles into urban infrastructure to improve energy efficiency and transport safety.
- T1– Smart Cities Case Studies: This tutorial focuses on case studies and practical projects related to smart cities. Students will have the opportunity to analyse concrete examples of existing smart cities such as Barcelona, Singapore, Amsterdam, among others. They will study the various initiatives implemented in these cities in terms of smart technologies, urban governance and environmental sustainability.
- T2– Smart buildings: This tutorial allows students to familiarise themselves with different aspects of smart buildings through interactive exercises and group discussions in order to understand the basics of smart buildings and explore their implications in the modern urban context.

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|                                                                                  |                                              |                             |
|----------------------------------------------------------------------------------|----------------------------------------------|-----------------------------|
|  | <b>Smart city : principes and challenges</b> | <b>PGE - S07 – UE ECD 3</b> |
|                                                                                  |                                              | 24/02/2026                  |
|                                                                                  |                                              | Page 2/2                    |

• P: Acquisition of data from End Device sensors via IoT : This involves learning about DidaLoraWan equipment and its components, connecting it to the End Device card and understanding how it works. Students will then set up and program a practical data acquisition case (C or Python program) via IoT using the End Device card and the LoRaWan protocol.

Student engineers will be assessed by means of a practical assessment mark and a final exam mark.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, engineering students will be able to:

- [1] Understand the fundamental principles of smart cities and their importance in the modern urban context.
- [2] Situate smart buildings within a global context: smart cities, connected objects, BIM, etc.
- [3] Acquire the fundamentals of smart grids and use the important terminology employed.
- [4] Analyse the impact of smart buildings and smart grids on energy management.

### Prerequisites

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- Issues in cities and regions – S05
- Planning and various networks – S05
- Energy policies, transition and engineering projects – S05
- Electrical system energy – S05
- Fundamental concepts in electrical networks and renewable energy.

### Learning material

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- RICHARD Paul-Henri, Crise et ville intelligente au prisme de l'éthique appliquée à la sécurité civile. PhD thesis, Troyes, 2016.
- CARNERO André, ALBA Enrique, Smart city and information technology: A review. Cities, 93:84–94, 2019.
- BUCKMAN Alex H, MAYFIELD Martin, BECK Stephen BM, What is a smart building? Smart and Sustainable Built Environment, 3(2):92–109, 2014.
- LATIFAH Ayu, SUPANGKAT Suhono Harso, RAMELAN Agus, Smart building: A literature review. In 2020 International Conference on ICT for Smart Society (ICISS), pages 1–6. IEEE, 2020?

|                                                                                  |                              |                             |
|----------------------------------------------------------------------------------|------------------------------|-----------------------------|
|  | <i>Finite Element method</i> | <b>PGE - S07 – UE MOD 3</b> |
|                                                                                  |                              | 24/02/2026                  |
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**Teaching language: English**

**Number of hours: 21.5h**

Lectures: 9h / Tutorials: 10h / Final assessment: 1,5h

### **Course description and assessment**

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The purpose of this course is to present an introduction to the finite element method applied to the calculation of elastic structures. The principles are presented and illustrated on plane structures loaded in their plane (bars, beams, membranes) but can be generalized to spatial structures.

#### **CM1: Principles of matrix calculations of structures**

This course presents the matrix formulation of the resolution of structures by the displacement method. It allows us to understand the establishment of nodal force vectors, vector of nodal displacements and the stiffness matrix of the structure. The stiffness of the member and beam elements is established, the principle of establishing the nodal forces of a loaded element is explained. The technique of assembling and projecting elementary rigidity matrices into the space of degrees of freedom is explained. The resolution of the displacement unknowns of the complete system then makes it possible to determine the deformations and stresses in the members.

#### **Tutorial 1: Resolving a reticulated planar structure**

Establishment of the elementary matrices, projection in the global frame of reference and assembly, establishment of the vector of the nodal forces. Resolution of the nodal displacements in the global frame of reference and then projection in each of the local frames of reference of the elements to establish the strain field and then the stress field in the bars. Use of the Excel tool and comparison with the classical method of solving by Strength of Materials.

#### **Tutorial 2: Solving a hyperstatic plane structure made up of beams**

Same principle as for the reticulated structure. Drawing up diagrams of internal forces (N, T, M) and extreme stresses. Comparison with the Strength of Materials displacement method.

#### **CM2: 2D Plane Elasticity Finite Elements**

Generalization of the matrix method to plane structures composed of triangles. Define and choose functions for interpolating displacements within elements. Approximation of the elementary stiffness matrix from the elasticity matrix and the derivatives of the interpolation functions. Consistency with the results established for the bar and beam elements. Approximate strain and stress fields.

Presentation of other elements, either with more nodes (quadrangles) or with higher degree interpolation polynomials (quadratic, cubic) for a better approximation of the displacement field.

#### **TD3: Solving a trapezoidal plate loaded in its plane**

Preparatory work: establishment of the elementary stiffness matrix of a triangular element in Excel.

In session: manual estimation of the mean membrane stress and support reactions. Matrix assembly, Displacement field resolution, Restitution at the elementary level: strain and stress fields. Comparison of consistency with manual calculations.

|                                                                                  |                              |                            |
|----------------------------------------------------------------------------------|------------------------------|----------------------------|
|  | <i>Finite Element method</i> | <b>PGE - S07 – UE MOD3</b> |
|                                                                                  |                              | 24/02/2026                 |
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CM3: Advanced notions for numerical calculation

Defining a reference element and shape functions. Notion of Jacobian. Expression of the elementary stiffness matrix by integration on the domain of the reference element.

Numerical technique for the calculation of the elementary stiffness matrix: Gaussian integration method.

TD4: Calculation of a finite element of a member loaded in its length and at its ends.

Resolution by the Strength of Materials. Resolution by two ilinear elements. Resolution by a quadratic element from the reference element, shape funtions, and Gaussian points. Comparison of results and discussions.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, engineering students will be able to:

- [2] understand the finite element method;
- [3] become informed users of computer tools for numerical simulation by finite elements in structural mechanics;
- [4] to identify the numerical problems that may arise in the mechanics of continuous media and the strength of materials and to choose the most suitable method and to estimate the validity of the results produced by the computer;
- [4] select appropriate modelling that takes into account the complexity of the structure and the intended objectives;
- [5] create a small Excel or Python program implementing the complete solution of a problem by the finite element method;
- [6] certify and validate the result of the simulation thus obtained by the judgments of engineers and based on the achievements of Strength of Materials.

### Prerequisites

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1. Mastery of the basics of Strength of Materials : calculation of internal efforts, stresses, strains in bars and beams, Hooke's law, Bresse equations
2. Mastery of the basics of linear elasticity: stress tensor, strain tensor, stress-strain relationship, application to plane elasticity.
3. Engineering Mathematics
4. Python or Excel programming

### Learning material

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- Michel Cazenave - Méthode des éléments finis – Approche pratique en mécanique des structures. Edition Dunod
- Gouri Dhatt & Gilbert Touzot – Une présentation de la méthode des éléments finis – Presses de L'université Laval (Québec) – Maloine S.A. (Paris)
- O.C. Zienkiewicz – The Finite Element Method : tis Basis and Fundamentals - Edition Elsevier
- J.S. Przemieniecki – Theory of Matrix Structural Analysis – Dover Publications Inc.

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|----------------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------------|
|  | <b>Introduction to geographic information systems<br/>GIS/MIS</b> | <b>PGE - S07 - UE MOD 3</b> |
|                                                                                  |                                                                   | 24/02/2026                  |
|                                                                                  |                                                                   | Page 1/1                    |

**Teaching language: English**

**Number of hours: 26,5h**

(Lectures:6 h-Tutorials:5 h-PROJECT:12,5-FOAD asynchronous 1 h)

## Course Description and Assignments

The module "Introduction to Geographic Information Systems (GIS)/CIM" is a common course of the teaching unit "Mathematics & Modeling." Its purpose is to introduce students to the concepts and methods of Geographic Information Systems (GIS) and Computer-Integrated Manufacturing (CIM) (City Information Model). This course covers the following topics:

- Spatial analysis in matrix and vector mode
- Exchange of geographic data: formats and methods
- Management of coordinates and projections in a GIS
- CIMs (City Information Models)

Online GIS mapping or Web mapping.

2 practical sessions to cover the following topics:

Practical Session 1: Interface and navigation, Symbolology, Labels, Attribute Tables, Attribute Queries, Spatial Queries, Layout

Practical Session 2: Connecting to ArcGIS Pro, Project creation and data integration, Data operations, Integrating BIM models into ArcGIS Pro via the IFC format, Sharing static and dynamic maps on ArcGIS Online.

Project 12h50, 12:50 project, spread over 5 work sessions, aimed at responding to professional requests in the field of GIS. The project topic varies each year according to different themes and available data. Its goal is to produce a cartographic output using ArcGIS Pro, to edit a map or a web service in ArcGIS Online, in order to create a StoryMap.Software.

used: ArcGIS Pro (ESRI editor) with extensions (Data Interoperability, etc.)

The practical work and the project will be carried out in groups of 2 students.

Assessment will be based on a practical work grade (25% of the final grade) and a project deliverable "digital format submission" (75% of the final grade).

*(Learning Outcomes)*

*[Bloom Taxonomy level] – scale from 1 to 6*

- [2] Recognize the basic concepts related to GIS and formats
- [2] Explain the differences between CAD, GIS, BIM, and CIM
- [2] Understand coordinate and projection management in a GIS
- [3] Apply a project management methodology for Geographic Information Systems

## Prerequisites

- Digital Programming Course - Data Analysis

## Learning Material

- Digital resources in geomatics from ENSG: <http://cours-fad-public.ensg.eu/>
- Geographic Information Systems and Science, P. Longley, M. Goodchild, D. Maguire, D. Rhind, 2005, Wiley
- Data in Geographic Information Systems, Paul Rouet - Hermes EditionsPaul Rouet - Éditions Hermes

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|----------------------------------------------------------------------------------|-----------------------------------------------------|----------------------------|
|  | <b>Digital tools for collaborative projects BIM</b> | <b>PGE - S07 – UE MOD3</b> |
|                                                                                  |                                                     | 24/02/2026                 |
|                                                                                  |                                                     | Page 1/1                   |

**Teaching language: English**

**Number of hours:** 12:5 h

Lectures: 2,5h-Tutorials: 10h

### **Course description and assessment**

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The collaborative BIM project digital tools allow students to work together in teams around a single digital model, centralized on a professional platform. Students are required to work on a case study in order to address the digital challenges in the field. During semester 07, the engineering students are expected to:

- Produce BIM models for different trades;
- Collaborate on a BIM project hosted on a professional collaborative platform;
- Exchange digital models using interoperability principles;
- Perform digital coordination of BIM models;
- Produce BIM technical documents.

Each group will be assessed based on a list of deliverables to be submitted on the BIM collaborative platform.

### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, the engineering student should:

- [3] Use collaborative BIM platforms to work as a team on a single centralized model;
- [4] Analyze BIM project documents;
- [5] Collaborate and manage the BIM project;
- [5] Integrate interoperability fundamentals for data management;
- [5] Produce BIM deliverables.

### **Prerequisites**

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- Have completed the module 'Parametric Project Modeling in BIM' of S06

### **Learning material**

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- Access to collaborative platforms and BIM software
- Project materials available on Ecampus
- Project specifications

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|----------------------------------------------------------------------------------|---------------------------------------------|----------------------------|
|  | <i>Climate engineering and dimensioning</i> | <b>PGE - S07 – UE MOD3</b> |
|                                                                                  |                                             | 24/02/2026                 |
|                                                                                  |                                             | Page 1/2                   |

**Teaching language: English**

**Number of hours: 21h**

Lectures: 12h / Tutorials: 7.5h / Final assessment: 1.5h

### **Course description and assessment**

The Climate Engineering and Design course in the Mathematics and Modelling teaching unit addresses aspects related to energy efficiency through the design of heating, ventilation, air conditioning and domestic hot water systems for the energy needs of a building.

- **L 1: Application of the elements covered in the prerequisite course ‘Energy’ through heat exchange in building systems:** Review and grouping of basic thermodynamics concepts with energy conservation and heat transfer mechanisms; Building System Energy Balances: Methodology for performing energy balances, Analysis of incoming and outgoing energy flows, Calculation of heat gains, Evaluation of a building's overall energy losses, Unified degree days (UDD); Concepts of air quality and thermal comfort: Reference indoor conditions, Reference outdoor temperatures, Hygienic air flow rates in residential buildings, Hygienic air flow rates in non-residential buildings, Regulations and health standards.
- **L 2: In-depth study of humid air:** humid air transformations, different psychrometric changes and psychrometric calculation elements: hot coil, dry cold coil, wet cold coil, steam humidifier, adiabatic humidifier, mixing box, adsorption dehumidification, principle of heat recovery, Design of air treatment cycles in winter and summer; **Air treatment systems:** Presentation of different air treatment systems, operation and components. Installations in buildings; Specific cases of air handling units and Canadian wells. **Air filtration:** areas of application, Types of dust and particles, Principle of particle capture, Main characteristics of a filter.
- **T 1: Applications of energy and mass balances in buildings:** Taking into account internal and external loads such as the contribution of occupants, internal and external inputs; Determining the temperature and flow rate of air supplied by a ventilation system. Verification of thermal comfort using Givoni's humid air diagram and air quality based on standards.
- **L 3: Sizing of air treatment systems:** Sizing of air treatment systems, Control of air flow, humidity and temperature of the air blown in, Heat recovery systems; Calculations of air renewal rates; Ventilation efficiency and measuring equipment; Sizing of components: diffusers, fans, ducts, calculation of air distribution networks; Application of an air distribution network study and selection of the corresponding fan.
- **T 2: Application to the sizing of air treatment systems.** Application of an air handling unit with air recirculation; Calculation of heating and/or cooling coil capacities; Sizing of humidifiers and dehumidifiers; Determination of fan capacity; Application to the sizing of a Canadian well and calculation of its efficiency.
- **L 4: Water-based heating/cooling systems:** Types and components of installations; Calculation and sizing of devices; System efficiency; Special cases of boilers or heat pumps. Domestic hot water production: Domestic hot water systems, Components of DHW production installations, Dimensioning of DHW production installations, Efficiency of DHW systems.
- **T 3: Application to the dimensioning of water systems for heating and DHW.** Energy balance of a building to quantify heat loss; Sizing of water radiators. Calculation of boiler

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|----------------------------------------------------------------------------------|---------------------------------------------|----------------------------|
|  | <i>Climate engineering and dimensioning</i> | <b>PGE - S07 – UE MOD3</b> |
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power; Application of sizing a heat pump coupled with underfloor heating; Application to the sizing of a domestic hot water system.

Engineering students will be assessed by means of a final exam.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, engineering students will be able to:

- [2] Master and understand aspects related to building energy efficiency;
- [3] Assess the risks of surface and interstitial condensation on building walls;
- [3] Perform mass and energy balances in buildings;
- [4] Design and analyse air treatment systems;
- [4] Design and analyse the components of building heating and cooling systems.

### Prerequisites

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- Mathematics: Analysis and Algebra - S05
- Fluid Mechanics and Hydraulics - S06
- Applied Thermodynamics - S05
- Heat Transfer - S06

### Learning material

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- AWBIH. B. Ventilation Systems. Routledge Ltd. 2007. 458 pp
- FLAMENT B., BOUVENOT J.B. Génie climatique et énergétique. Eyrolles Editions. 2019. 338
- RECKNAGELI h., SPRENGER., SCHRAMEK e-r., Génie Climatique, Dunod, 2011, 200 p

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|----------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------|
|  | <b>Life Cycle analysis of a structure : method and tools</b> | <b>PGE - S07 – UE MOD3</b> |
|                                                                                  |                                                              | 24/02/2026                 |
|                                                                                  |                                                              | Page 1/2                   |

**Teaching language: English**

**Number of hours: 17.5h**

Lectures: 3h / ODL (As: 6h) / Tutorials: 7.5h / Final assessment: 1h

### **Course description and assessment**

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The LCA course, part of the core curriculum of the 'Mathematics and Modelling' teaching unit, aims to train students to understand and use the eco-design tool of Life Cycle Assessment (LCA). The courses and case studies offered emphasise the importance of a comprehensive, multi-criteria, multi-scale approach covering the entire life cycle of the structure, putting LCA into perspective in relation to current regulatory requirements.

The module is designed as a flipped classroom and makes use of resources from the ACV Digital Learning programme.

Assessment is based on a one-hour final exam.

The overall content of the module is as follows:

- Methodological and scientific approach to LCA
  - Reminders on CSR
  - Normative and regulatory context of the LCA tool
  - Concept of the life cycle of a product/structure
  - Multi-criteria approaches
  - Methodological framework of LCA
    - Method at the component level
  - Environmental and Health Declaration Sheet (FDES): definition, examples
  - FDES configurators
  - Use of FDES and the data they provide
    - From component to structure
  - Collaboration between engineers and architects on eco-design
  - LCA calculation tools
  - Case studies
    - Limitations of LCA, ongoing research to further its development It is organised as follows:

| Format                  | Duration | Content                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Cours 1 (L1)</b>     | 01 :30   | <ul style="list-style-type: none"> <li>- Presentation of the module content and its organisation</li> <li>- Methodological and scientific approach to Life Cycle Assessment (LCA)</li> <li>- Introduction to LCA at the component level / case study of FDES</li> </ul>                                                                                                                                            |
| <b>Asynchronous AS1</b> | 02 :15   | The LCA method and its application at the element level : <ul style="list-style-type: none"> <li>- Social and environmental responsibility :</li> <li>- Notion de cycle de vie d'un produit / d'un ouvrage</li> <li>- Approche multicritère</li> <li>- Fiches support : glossaire, normes, outils, indicateurs d'IE, liens utiles</li> <li>- FDES : contenu et exemples</li> <li>- Configureurs de FDES</li> </ul> |
| <b>Tutorial 1 (T1)</b>  | 02 :30   | Multi-criteria analyses at the element level : comparison of FDES, multi-criteria and multi-stage analysis                                                                                                                                                                                                                                                                                                         |
| <b>Lecture 2 (L2)</b>   | 01 :30   | <ul style="list-style-type: none"> <li>- Review of LCA methodological concepts covered in class and in asynchronous sessions</li> <li>- Normative and regulatory context of the LCA tool : RE2020 and its requirements, social and environmental responsibility...</li> </ul>                                                                                                                                      |
| <b>Asynchronous AS2</b> | 02 :00   | LCA applied at the structure level : <ul style="list-style-type: none"> <li>- Collaboration between engineers and architects</li> <li>- Tools at the structure level</li> </ul>                                                                                                                                                                                                                                    |
| <b>Tutorial 2 (T2)</b>  | 02 :30   | Application of LCA to buildings : analysis of alternative solutions                                                                                                                                                                                                                                                                                                                                                |
| <b>Asynchronous 3</b>   | 02 :00   | LCA applied to structures : <ul style="list-style-type: none"> <li>- Case study of the LCA of a bridge</li> <li>- Example of research work</li> </ul>                                                                                                                                                                                                                                                              |
| <b>Tutorial 3 (T3)</b>  | 02 :30   | Example of the application of LCA to a public work structure                                                                                                                                                                                                                                                                                                                                                       |
| <b>Asynchronous 4</b>   | 00 :15   | End of course                                                                                                                                                                                                                                                                                                                                                                                                      |

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

Be able to perform an LCA – Understand, analyse and perform a simple LCA at multiple scales, and know how to use an LCA in an eco-design process *[Level 6 – Assessment]*

- [1] Define the scope of the system to be studied and the endogenous (CSR) / exogenous (regulations) objectives targeted;
- [2] Identify the steps to be taken into account and search for relevant data;
- [4] Analyse the data manually or using software, evaluate the scale effects of the material, from the structure to the construction solution;
- [5] Propose optimisation levers in relation to the objectives targeted.

### Prerequisites

- Sustainable Construction Issues
- Construction Science and Techniques

### Learning material

- Sources cited in teaching materials
- LCA Digital Learning :  
[https://www.youtube.com/playlist?list=PLtkIWzOv5Jz2A\\_uLzbJz\\_6CET-M3umD4r](https://www.youtube.com/playlist?list=PLtkIWzOv5Jz2A_uLzbJz_6CET-M3umD4r)

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|----------------------------------------------------------------------------------|------------------------|-----------------------------|
|  | <b>Cost accounting</b> | <b>PGE - S07 – UE MGT 3</b> |
|                                                                                  |                        | 24/02/2026                  |
|                                                                                  |                        | Page 1/1                    |

**Teaching language: English**

**Number of hours:** 15.5h

Lectures: 9h/ Tutorials: 5h / Final assessment:1.5h

### Course description and assessment

Cost accounting, a core course in the "Project Management and Business Management" teaching unit, covers the following costs and performance aspects of an organization:

- Introduction to cost accounting
- Treatment of direct and indirect expenses
- Maintaining a perpetual inventory
- Full costing method
- Variable costing method and calculating the break-even point
- Partial costs, analysis, and contribution

The assessment of learning outcomes will be conducted during a final assessment.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

**At the end of this course, the engineering student will be able to:**

- [2] Outline the company's strategy and its environment
- [3] Use cost accounting as a decision-making tool
- [2] Describe the general mechanisms of cost accounting
- [3] Calculate a cost price and an analytical result
- [3] Prepare a quote
- [3] Produce a profitability study for decision-making purposes.

### Prerequisites

- Business Economics
- General Accounting

### Learning material

- Le petit compta – Charles Edouard Godart - 2024
- Comptabilité générale - Cours et Exercices corrigés - Alan Judikael - 2018
- Comptabilité de gestion Grand livre 8 - Alain Amintas, Raymond Guillouzo - 2020

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|----------------------------------------------------------------------------------|----------------------|-----------------------------|
|  | <b>Price studies</b> | <b>PGE - S07 – UE MGT 3</b> |
|                                                                                  |                      | 24/02/2026                  |
|                                                                                  |                      | Page 1/1                    |

**Teaching language: English**  
**Number of hours:** 10,5 h  
 Lectures 4,5h and Tutorials 5h

### **Course description and assessment**

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The pricing study, a core course of the teaching unit 'Project Management and Business Management,' covers the main principles of pricing studies and project organization.

- Price study & Methodology
- Role and tasks of a business engineer and price study
- Analyze a market file, a company consultation file
- Prepare a quote
- Use price revision formulas
- Study of selling price (Call for tenders)
- International price study
- Define the work budget

The assessment will be in the form of a one-hour written composition.

### **Learning outcomes**

*[The Bloom Taxonomy level] – scale from 1 to 6*

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- [2] Describe the structuring of a price study
- [2] Explain the different aspects of a price study in response to a call for tenders
- [2] Explain the role of stakeholders, the organization of the phases of a consultation of a file
- [4] Create a price study in response to a call for tenders
- [3] Produce the selling price

### **Prerequisites**

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- Introduction to project management

### **Learning material**

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- Price study in the building

|                                                                                  |                           |                             |
|----------------------------------------------------------------------------------|---------------------------|-----------------------------|
|  | <b>Project management</b> | <b>PGE - S07 – UE MGT 3</b> |
|                                                                                  |                           | 24/02/2026                  |
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**Teaching language: English**

**Number of hours: 14h**

Project:15h

### **Course description and assessment**

This core course, part of the "Project Management and Business Administration" unit, introduces engineering students to the fundamental principles of project management as applied to the construction sector. It aims to equip students with methods, tools, and best practices to efficiently manage a project from initiation to closure, considering the specificities of the construction industry: technical complexity, multiple stakeholders, and challenges related to cost, schedule, quality, and safety. Emphasis is placed on structuring, planning, risk management, and operational monitoring of construction projects.

#### **Course Content**

- Objectives, definition, and project life cycle overview
- Stakeholder identification (review from first-year courses)
- Project structuring (WBS = ABS × PBS × ZBS)
- Project planning: defining objectives, deliverables, and timelines
- Project budgeting
- Resource allocation and mobilization
- Risk identification and management (review: categories to align with the specific Risk Management module, including project failure risks and key success factors)
- Implementation of relevant indicators, project monitoring, and progress control

Assessment: Learning outcomes will be evaluated through a final exam.

#### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of the course, the student will be able to:

- [1] Identify the roles of stakeholders and the organization of project phases
- [2] Describe and break down a project into processes and sub-processes
- [4] Analyze project complexity using technical tools and structuring methods
- [3] Develop a project plan using appropriate tools

#### **Prerequisites**

Stakeholders, Challenges, and Design Project Management

- Construction Site Organization and Supervision
- Occupational Health and Safety – Level 1 (OHS 1)

#### **Learning material**

- Guide and Standards - A Guide to the Project Management Body of Knowledge – PMBOK (PMBOK® Guide) –5th or 6th Edition (6th includes Agile)
- ISO 21502 de 2021 Management de projets, programmes et portefeuilles- Recommandations sur le management de projets
- Antimanuel de management de projet - Thomas Reverdy – 2021
- Piloter votre projet - Isabelle Laurent Collin – 2021
- Dictionnaire de management de projet – AFITEP - 2010

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|----------------------------------------------------------------------------------|----------------------|-----------------------------|
|  | <b>Business Game</b> | <b>PGE - S07 – UE MGT 3</b> |
|                                                                                  |                      | 24/02/2026                  |
|                                                                                  |                      | Page 1/1                    |

**Teaching language:** English

**Number of hours:** 15h

Project:15h

## Course description and assessment

**Business Game**, a core project within the "Project Management and Business Administration" unit, the Business Game is a two-day immersive experience designed to develop students' knowledge of strategic and decision-making management in R&D, finance, marketing, production, logistics, and CSR within an international group operating in a competitive and constantly evolving environment over five simulated business years.

### Objectives and Learning Approach

- Immersive approach to the development of an international company
- Apply financial and managerial knowledge in a competitive, international environment
- Understand the dynamics of international markets
- Develop soft skills: teamwork, conflict resolution, critical thinking, communication, and problem-solving

**Assessment:** Learning outcomes will be evaluated based on the performance results achieved during the business simulation and an oral presentation.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of the course, the student will be able to:

- [3] Develop and manage a company's strategy in a competitive environment
- [2] Understand CSR-related challenges in the company's strategic development choices
- [3] Produce a business plan
- [3] Develop collaborative and project-based work skills
- [3] Present the company's results, current situation, and future vision

### Prerequisites

- Business Economics
- Financial and Managerial Accounting
- Project Management

### Learning material

- [Les 10 notions clés de la stratégie d'entreprise](#) – Denis Lacoste - 2021
- Strategor – Bernard Garette [et al.] - 2019

|                                                                                  |                    |                             |
|----------------------------------------------------------------------------------|--------------------|-----------------------------|
|  | <b>Geotechnics</b> | <b>PGE - S07 – UE STC 3</b> |
|                                                                                  |                    | 24/02/2026                  |
|                                                                                  |                    | Page 1/1                    |

**Teaching language: English**

**Number of hours: 25 h**

Lectures:9h; Tutorials:6h; FOAD:1h Evaluation: 1,5h

### Course description and assessment

This core course, part of the teaching unit 'Sciences and Methods of Engineering,' follows that of semester 6 and allows students to continue acquiring the essential knowledge required to master the concepts needed for analyzing soil strength and deformation.

The main concepts covered are:

- Les phénomènes de tassement et de consolidation des sols
  - Reminder: Calculation of stresses in soils
  - Terzaghi's Consolidation Theory
  - Measurement of compressibility – oedometer test
- The shear strength of soils:
  - Notion of intrinsic curve – Mohr-Coulomb criterion
  - Total and effective stresses – Short- and long-term behavior of soils
  - Measurement of shear strength
- Slope stability:
  - Introduction et exemples
  - Sliding plan
  - Circular sliding, slice method
  - Monitoring methods
  - Reinforcement methods

The practical work focuses on:

- The oedometer test
- The triaxial test (unconsolidated)

The assessment will be based on a final exam and the average of the lab reports.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [5] Calculate total and effective stresses;
- [4] Determine the shear strength of soils;
- [4] Analyze consolidation and calculate the settlement of fine soils;
- [3] Describe the failure mechanisms of slopes.

### Prerequisites

- Soil mechanics program for semester S6
- Basic knowledge of continuum mechanics.
- General knowledge in mechanics + strength of materials (SOM).

### Learning material

- Éléments de mécanique des sols, François Schlosser, Presses de l'ENPC, 1997
- Ouvrages et fondations en terre, Gérard PHILIPPONNAT, Bertrand HUBERT – Eyrolles, 1997
- Théorie et pratique de la géotechnique - Tome 1, Outils pour la conception des ouvrages, Claude PLUMELLE - Collection Expertise technique, 2017 ;
- Vidéos pédagogiques du cfms jeunes :  
<https://www.youtube.com/playlist?list=PLQg3J2byMVWJ6e9vQCwa5diJcT8p0Pd89>

|                                                                                  |                            |                             |
|----------------------------------------------------------------------------------|----------------------------|-----------------------------|
|  | <b>Reinforced concrete</b> | <b>PGE - S07 – UE STC 3</b> |
|                                                                                  |                            | 24/02/2026                  |
|                                                                                  |                            | Page 1/2                    |

**Teaching language: English**

**Number of hours: 25h**

Lectures: 10,5h - Tutorials: 12,5h - Evaluation: 2 h

### **Course Description and Assignments**

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This core course, from the teaching unit 'Construction Sciences and Techniques,' covers the reinforcement methods for simple reinforced concrete structural elements under static loads according to the European regulation Eurocode 2. The main topics covered are:

- The definition of reinforced concrete and characterization of steel and concrete materials according to EC2
- The calculation basis for reinforced concrete elements at ultimate and service limit states according to EC2
- The calculation of the concrete cover for reinforced concrete elements
- The sizing of reinforced concrete columns
- The study of a rectangular reinforced concrete beam in simple bending
- The study of a T-beam in reinforced concrete under simple bending
- The calculation of beams for shear force

It is organized according to the following chronological sequence:

#### Lecture – Chapter 1- Eurocode Basics, Materials, Concrete Cover (durability)

Eurocode Basics, Eurocode 2, Materials, Calculation of concrete cover (depending on the exposure class).

#### Lecture– Chapter 2 – Sizing of the posts

Calculation of columns (under simple compression)

- Tutorial 1 – Calculation of coating and sizing of posts:

Practice of calculating concrete cover (based on the data available in a specifications sheet, including the exposure class); design of columns under simple compression.

#### Lecture – Chapter 3 – Sizing of a beam (rectangular section and T-section) at the ULS

Longitudinal reinforcements: Rectangular section, T-shaped section

- Tutorial 2 – Design of a section in simple bending at the ULS (Rectangular section)
- Case study of a beam subjected to simple bending (ULS), calculation of the longitudinal reinforcement section, diagram.
- Tutorial 3 – Sizing of a section under simple bending at the ULS (T-section) Study on the case of the Beam subjected to simple bending (ULT), calculation of longitudinal reinforcement section, diagram.

#### Lecture – Chapter 4 – Serviceability Limit State (SLS) Calculation

Constraints, cracks,

|                                                                                  |                            |                             |
|----------------------------------------------------------------------------------|----------------------------|-----------------------------|
|  | <b>Reinforced concrete</b> | <b>PGE - S07 – UE STC 3</b> |
|                                                                                  |                            | 24/02/2026                  |
|                                                                                  |                            | Page 2/2                    |

- Tutorial 4 – Calculation at the ELS

Case study of a rectangular section beam (SLS), verification of stresses in the concrete and in the longitudinal reinforcements.

Lecture – Chapter 5 – Calculation of beams for shear force (ULS)

Connecting rods, cross braces

- Tutorial 5 – Calculation of beams for shear force (ULS)

Case study of a rectangular section beam (ULS), calculation of the transverse reinforcement section, diagram.

**The assessment** will be based on a **final exam (2 hours)**.

### Learning Outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, the engineering student will be able to:

- [4] Calculate the basic reinforced concrete structural elements under simple loading according to Eurocode 2, justifying the principles and methods used
- [4] Explain the concept of limit state and durability in a project
- [3] Determine steel sections for structural elements according to current regulations
- [3] Apply the construction provisions of steel for simple structural elements

### Prerequisites

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- Design of Structures and Eurocodes
- Mechanics of Continuous Media
- Strength of Materials 1 course

### Learning Material

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- Pratique de l'Eurocode 2 – Guide d'application, Jean ROUX - Edition Eyrolles
- Paille J.M., Calculs des structures en béton – Guide d'application - Edition Eyrolles
- Eurocode 2
- Aide-mémoire - Ouvrages en béton armé - 6e édition ; Arnaud Bury

|                                                                                  |                             |                             |
|----------------------------------------------------------------------------------|-----------------------------|-----------------------------|
|  | <b>Prestressed concrete</b> | <b>PGE - S07 – UE STC 3</b> |
|                                                                                  |                             | 24/02/2026                  |
|                                                                                  |                             | Page 1/2                    |

**Teaching language: English**

**Number of hours:** 15,5 h

Lectures: 9h; Tutorials: 5h; Assessment: 1,5h

### Course description and assessment

The course on prestressed concrete, integrated into the teaching unit "Construction Science and Technology," offers students comprehensive training on the design and sizing of a prestressed concrete beam (PCB) in accordance with the European Eurocode 2 standard, as well as on prestressing technologies and processes.

This course aims to teach students the theoretical basics of calculating sections in prestressed concrete, to introduce them to the technology and specificities related to the use of prestressing. The course is structured in three parts:

Lecture 1: General principles of prestressing (pre-tensioning, post-tensioning, prestressing technology) as well as its specific characteristics, particularly the losses of prestress related to the changes in material properties over time.

Lecture 2: Design of prestressing for the uncracked SLS: concept of overcritical and undercritical sections, determination of prestressing ranges, determination of the stress distribution zone.

Lecture 3: Verification and reinforcement at the ultimate limit state under bending moment and shear force. Determination of the resisting moment of a prestressed concrete section with or without passive reinforcements.

The course is accompanied by two tutorials that will cover the CM2 and CM3 lectures with a simplified approach to estimating prestress losses.

**The assessment** will be based on a **final exam (1.5 hours)**

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

- [3] Understand the general techniques of pre-tensioning and post-tensioning (technology and construction arrangements) as well as the different characteristics of the materials.
- [4] Perform the design of the active and passive prestressing section according to Eurocode 2.
- [3] Design a prestressing solution for statically determinate structures under the uncracked serviceability limit state (SLS).
- [3] Design a prestressing solution for statically determinate structures under the ultimate limit state (ULS).

### Prerequisites

- Mastery of the basics of strength of materials in the first year: determination of internal forces in statically determinate structures, calculation of normal stresses in combined bending
- Mastery of mechanical characteristics of cross-sections: area, moment of inertia, core, mechanical efficiency.
- Mastery of the fundamentals of the Eurocode: partial safety factor method, SLS and ULS combinations, characteristics of concrete and steel materials (as covered in the reinforced concrete course)
- Mastery of the calculation of reinforced concrete sections at ULS: bending and shear

|                                                                                  |                             |                             |
|----------------------------------------------------------------------------------|-----------------------------|-----------------------------|
|  | <b>Prestressed concrete</b> | <b>PGE - S07 – UE STC 3</b> |
|                                                                                  |                             | 24/02/2026                  |
|                                                                                  |                             | Page 2/2                    |

### **Bibliographie et ressources complémentaires** (*Learning material*)

- Réglementation Eurocode 2 : Calcul des structures en béton
- P. LE DELLIOU, Béton précontraint aux Eurocodes , Collection ENTPE
- Eurocode 2 : guide méthodologique d'application aux ponts-routes en béton / SETRA (décrivant de façon détaillée et pratique les justifications aux Eurocodes d'un ouvrage d'art)
- G.DREUX, Cours pratique de béton précontraint
- Y.GUYON, Construction en béton précontraint
- H.THONIER, Le béton précontraint aux états limites, Presses de l'Ecole Nationale des Ponts Chaussées
- J.FAUCHET, Cours de béton précontraint
- La précontrainte par Albert CHAUSSIN et R. LA CROIX
- BA-CORTEX : site Internet dédié à la formation au dimensionnement de structures en béton selon les Eurocodes, il est d'accès libre et contient des modules de cours, d'applications et de projets
- Procédés de précontrainte : consultables et téléchargeables sur les sites des différentes sociétés distribuant la précontrainte : Freyssinet, Etic, DSI, Spie, Précontrainte, BBR etc.

|                                                                                  |                                                |                             |
|----------------------------------------------------------------------------------|------------------------------------------------|-----------------------------|
|  | <b>Steel construction and other structures</b> | <b>PGE - S07 – UE STC 3</b> |
|                                                                                  |                                                | 24/02/2026                  |
|                                                                                  |                                                | Page 1/1                    |

**Teaching language: English**

**Number of hours:** 23,5 h

Lectures: 12h-Tutorials: 10h – FOA – Assessment: 1,5h

### Course Description and Assignments

The course on metal construction, part of the teaching unit "Sciences and Techniques of Construction," allows students to acquire general knowledge in metal construction.

Capsules used: Prerequisites

- Vocabulary, terminology
- Steel in construction, metal construction products
- Steel: history, design, case studies

- Lecture 1 : Characteristics of steel (material, mechanical strength, metallurgy)  
Regulations, actions, Design method, and actions on the structure

- Lecture 2: Sizing:
  - of an element under simple tension
  - of a column under simple compression (taking buckling into account)

- Lecture 3 : Design and Sizing of Beams Subjected to Simple Loads (Taking Lateral Torsional Buckling into Account)
- Lecture 4 : Design Principles of Joints: Bolts, Preloaded Bolts, Welding

Tutorials :

- Tutorial 1 : Design and sizing of a structural tension element-
- TD 2 : Design and sizing of a structural compression element-
- TD 3 : Design and sizing of a structural element in simple bending-
- TD 4 : Design and sizing of an assembly

The student's assessment is carried out by:

- An assessment at the end of a course (20% of the final grade) - Forms / Woodclap (induced activity)
- A composition (design and sizing of a structural element; 80% of the final grade)

### Learning Outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

- [2] Apply a structured design approach for a metal structural element,
- [4] Master the checks of steel structural elements under basic loads according to Eurocode 3,
- [5] Know how to identify and choose steel and a profile in simple cases.

### Prerequisites

- Materials Science Teaching-S05
- Construction Materials Engineering Teaching-S05
- Strength of Materials Teaching - S06

### Learning Material

- Construire Acier, [Home - ConstruireAcier](#)
- LEMOINE B., LANDOWSKI M., Concevoir et Construire en Acier, Eyrolles

|                                                                                  |                                     |                             |
|----------------------------------------------------------------------------------|-------------------------------------|-----------------------------|
|  | <b>Construction site technology</b> | <b>PGE - S07 – UE STC 3</b> |
|                                                                                  |                                     | 24/02/2026                  |
|                                                                                  |                                     | Page 1/1                    |

**Teaching Language : English**

**Number of Hours : 13h**

Lectures : 9h ; Tutorials :2,5h and Assessment:1,5h

### Course description and assessment

Construction site technology, a course in the teaching unit 'Construction Science and Techniques,' aims to provide the keys to understanding the methodology of structural work, on the one hand for earthwork operations, and on the other hand for building method operations (study, definition, sizing, implementation).

Topics covered:

- La The composition of an earthmoving workshop.
- Le The sizing of production equipment (loader, excavator) & transport equipment (truck, dump truck), versatile machinery (scraper), and grading equipment (grader, compactor).
- Organizing an earthworks site
- The operation of structural work methods. Choosing construction principles.
- The characteristics of vertical and horizontal formwork.
- The equipment and techniques offered by main formwork suppliers.
- The characteristics of scaffolding and shoring (methodology, permits...)
- The characteristics and selection of equipment for concrete production and transportation.
- Technical and economic comparative studies; Example: Comparative tables of different types of floors.
- Waste management
- Lecture 1: Vertical and horizontal formwork.
- Lecture 2 : Earthworks. Retaining walls. Waste management.
- Lecture 3: The production and transportation of concrete, major construction methods, construction choices, and comparative studies will be explained
- Tutorial: Principles of formwork rotation, precast walls, cast-in-place floors & Crane loads
- The assessment of learning achievements will be carried out during a final examination.

### **Learning outcomes**

*[Bloom Taxonomy Level] – scale from 1 to 6*

- [2] Understand the different types of earthworks & know the various stages
- [2] Understand the cost and organization of an earthworks site.
- [1] Know the sizing of vertical and horizontal formwork and their components.
- [2] Know the equipment offered by formwork suppliers.
- [3] Decide on operating procedures.
- [2] Know the parameters for transporting concrete.
- [3] Have tools to make construction choices through technical and financial comparative studies.
- [2] Be aware of important topics for site execution monitoring: applications, and have some keys for budget tracking.
- [4] Decide on operating procedures.

### **Prerequisites**

Topography Course (Topographic Instruments S06), Site Organization 6.1 & General Construction.

- Worker Internship
- Site Visits

|                                                                                  |                                                |                             |
|----------------------------------------------------------------------------------|------------------------------------------------|-----------------------------|
|  | <h1 style="text-align: center;">Acoustics</h1> | <b>PGE - S07 – UE STC 3</b> |
|                                                                                  |                                                | 24/02/2026                  |
|                                                                                  |                                                | Page 1/1                    |

**Teaching language: English**

**Number of Hours:** 15,5 h

Lectures: 9h; Tutorials: 5h – Assessment: 1,5h

## Course Description and Assignments

The acoustics, from the teaching unit "Construction Science and Technology," addresses the general rules concerning acoustic behavior:

- Lecture 1 : Fundamental concepts including regulations (acoustic regulations and environmental acoustics; physical acoustics),
- Lecture 2 : Room acoustics & Acoustic correction
- Lecture 3 : Acoustic insulation
  
- Tutorial 1 : Fundamental concepts, Acoustic correction of the building
- TD2 : Acoustic insulation & insulating materials, Dimensioning and Verification
- The engineering student will be assessed by a final exam.
  
- E-learning path (optional)/ as a supplement:
  - 1- Physical Acoustics
    - a. Types, propagation, measurement, sound insulation, regulations, comfort, acoustic quality
    - b. Quizz
  - 2- Room Acoustics
    - a. Reflection Diffusion - Diffraction - Absorption
    - b. Geometrical / Statical approach
    - c. Quizz
  - 3- Acoustic Isolation
    - a. Correction and isolation of acoustics
    - b. Quizz

## Learning Outcomes

*[Bloom Taxonomy Level] – scale from 1 to 6*

- [1] to interpret normative and regulatory texts,
- [3] to analyze acoustic specifications of the Markets (Acoustic Notice, CCTP, etc.),
- [4] to analyze calculation notes from technical engineering offices,,
- [2] to read and use a test report, product technical documentation,
- [3] to master general rules concerning the acoustic behavior of a building,
- [3] to monitor the implementation of acoustic works.

## Prerequisites

- Engineering Mathematics 1 & 2.
- Signal Processing.

## Learning Material

- *L'acoustique de l'habitat*, Michel Chagué
- *L'isolation acoustique*, Amandine Maillet
- Mise en oeuvre des réglementations

|                                                                                  |                                         |                           |
|----------------------------------------------------------------------------------|-----------------------------------------|---------------------------|
|  | <b>Leadership &amp; communication 3</b> | <b>PGE - S07 – UESK 3</b> |
|                                                                                  |                                         | 24/02/2026                |
|                                                                                  |                                         | Page 1/1                  |

**Teaching language: English**

**Number of hours: 11.5h**

Lectures: 3h / Project: 5h / ODL (As:1h), Project assessment:2.5h

### Course description and assessment

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Leadership and Communication,

This core course, part of the "Communication and Career Development" unit, introduces the key principles of leadership and the adaptation of professional communication.

#### Course Content

- Introduction to leadership (styles, theories, situational leadership)
- In-depth focus on interpersonal communication (active listening, dialogue, feedback)
- Development of public speaking skills (choice of words, language, tone)

Assessment: Learning outcomes will be assessed through group work, oral presentations, and a team report.

#### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of the course, the student will be able to:

- [3] Apply a communicator's mindset in relational approaches
- [2] Summarize and consolidate knowledge related to leadership behaviors
- [3] Use public speaking techniques to become an effective communicating engineer
- [3] Develop an agile communication posture in group settings
- [3] Build a structured and persuasive argument

### Prerequisites

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- Leadership and communication 1

### Learning material

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- Philippe Breton, L'argumentation dans la communication, collection « Repères », La découverte, 2016
- Supports et activités publiés sur la plateforme eCampus
- Les quatre accords tolèques de Miguel Ruiz, Edition Jouvences - 1997
- L'intelligence émotionnelle : Intégrale de Daniel Goleman – Edition poche – 2014

# ***Semester 8 – Course descriptions***

## S8 Curriculum

| Teaching Unit (UE) | S8 Curriculum / Spring semester                                         | Study hours per Teaching Unit (UE) | Study hours per course | ECTS credits | Weighting in the UE |
|--------------------|-------------------------------------------------------------------------|------------------------------------|------------------------|--------------|---------------------|
| <b>UE ECD4</b>     | <b>Sustainable Construction Challenges</b>                              | <b>53,50</b>                       |                        | <b>3</b>     |                     |
| UE ECD4            | Construction Hackathon                                                  |                                    | 15,00                  |              | 1                   |
| UE ECD4            | Construction management and site handover                               |                                    | 21,00                  |              | 1                   |
| UE ECD4            | Ecological engineering                                                  |                                    | 17,50                  |              | 1                   |
| <b>UE MGT2</b>     | <b>Project Management and Business</b>                                  | <b>41,00</b>                       |                        | <b>4</b>     |                     |
| UE MGT2            | Construction law                                                        |                                    | 10,50                  |              | 1                   |
| UE MGT2            | Public and private markets                                              |                                    | 10,50                  |              | 1                   |
| UE MGT2            | Intercultural management                                                |                                    | 10,50                  |              | 1                   |
| UE MGT2            | Occupational Health and Safety 2                                        |                                    | 9,50                   |              | 1                   |
| <b>UE parcours</b> | <b>Thematic module - Low-carbon public works</b>                        | <b>260,00</b>                      |                        | <b>20</b>    |                     |
| UE parcours        | Courses detailed below                                                  |                                    | 260                    |              |                     |
| <b>UE SK4</b>      | <b>Communication and Professional Project</b>                           | <b>44,50</b>                       |                        | <b>3</b>     |                     |
| UE SK4             | Leadership & Communication 4 (including portfolio)                      |                                    | 11,50                  |              | 1                   |
| UE SK4             | ESTP Professional Conferences                                           |                                    | 3,00                   |              |                     |
| UE SK4             | English                                                                 |                                    | 30,00                  |              | 2                   |
|                    | <i>French as a Foreign Language (international students) – optional</i> |                                    | 30,00                  |              |                     |
|                    | <i>Main Foreign Language (German or Spanish) – optional</i>             |                                    | 30,00                  |              |                     |
|                    | <i>Additional Foreign Language – optional</i>                           |                                    | 16,50                  |              |                     |
|                    |                                                                         | <b>399,00</b>                      |                        | <b>30</b>    |                     |

## S8 Curriculum

### Thematic module - Low-carbon public works

| Teaching Unit (UE) | S8 Curriculum / Spring semester<br>Thematic module - Low-carbon public works | Study hours per Teaching Unit (UE) | Study hours per course |
|--------------------|------------------------------------------------------------------------------|------------------------------------|------------------------|
| <b>UE TPD ID</b>   | <b>Roads, regional planning and environment</b>                              | <b>74,00</b>                       |                        |
| UE TPD ID          | Earthworks and support                                                       |                                    | 22,00                  |
| UE TPD ID          | Road structures                                                              |                                    | 34,00                  |
| UE TPD ID          | Road layout                                                                  |                                    | 21,00                  |
| <b>UE TPD SOA</b>  | <b>Engineering structures</b>                                                | <b>73,00</b>                       |                        |
| UE TPD SOA         | Calculation of hyperstatic structures                                        |                                    | 19,00                  |
| UE TPD SOA         | Calculation of reinforced concrete structures                                |                                    | 18,50                  |
| UE TPD SOA         | Sizing of structures                                                         |                                    | 19,00                  |
| UE TPD SOA         | Bridge design and prestressed concrete                                       |                                    | 16,50                  |
| <b>UE TPD ECR</b>  | <b>Networks and Environment</b>                                              | <b>53,00</b>                       |                        |
| UE TPD ECR         | Ecology of materials                                                         |                                    | 21,00                  |
| UE TPD ECR         | Water development and environment                                            |                                    | 15,50                  |
| UE TPD ECR         | Maritime works and pathologies                                               |                                    | 16,50                  |
| <b>UE TPD PJ</b>   | <b>Engineering and research project 2</b>                                    | <b>60,00</b>                       | <b>60,00</b>           |
| UE TPD PJ          |                                                                              |                                    |                        |
|                    |                                                                              | <b>260,00</b>                      |                        |

|                                                                                  |                                                                          |                           |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------|---------------------------|
|  | <b>Geotechnical Engineering 2 – Foundations and Retaining Structures</b> | <b>PGE - S08 – UE TPD</b> |
|                                                                                  |                                                                          | 24/02/2026                |
|                                                                                  |                                                                          | Page 1/2                  |

**Teaching Language: English**

**Number of Hours: 22 h**

(Lectures: 12 h – Tutorials: 5 h – Evaluation: 2 h – Practical Work: 3 h)

### Course Description and Assignments

The course « **Geotechnics 2 – Foundations / Retaining Structures** », part of the « **Infrastructure** » teaching unit within the « **Decarbonized Public Works** » thematic track, follows the core modules on soil mechanics and geotechnics. It allows students to deepen the knowledge acquired in previous semesters and to gain a solid foundation in the design, behavior, and sizing of shallow and deep foundations as well as earth or retaining structures.

The following topics will be covered:

1. Calculation of Foundations
  - Shallow foundations: definition, principle of justification, estimation of settlements
  - Deep foundations: definition, types of deep foundations, bearing capacity, settlement, horizontal forces, negative friction
2. Earth or retaining structures
  - Plastic thrust and support
  - Gravity walls, reinforced concrete walls, reinforced soil
  - Retaining screens
  - Elastoplastic behavior of soils
  - Principles of justification
  - Deformation estimates
  - Limit equilibrium method
  - Soil-structure interaction, reaction coefficient, finite elements

Lab: Measurement of soil mechanical parameters to determine the bearing capacity of shallow and deep foundations. The pressuremeter test will be carried out for the French-speaking class (PI and pressuremeter modulus E) and the Panda Dynamic Penetrometer test will be performed for the English-speaking class (Tip resistance  $q_d$ ) as part of the lab.

The evaluation will be based on a 2-hour final exam and a 3-hour lab, which accounts for  $\frac{1}{4}$  of the final grade.

### Learning Outcomes :

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [5] Explain and justify the sizing and rationale for shallow and deep foundations;
- [4] Formulate the principles for justifying foundations and retaining structures according to the Eurocodes;
- [3] Derive a technical foundation solution based on a geotechnical investigation study;
- [1] Describe the regulations in the geotechnical field

|                                                                                  |                                                                                 |                           |
|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------|
|  | <b><i>Geotechnical Engineering 2 – Foundations and Retaining Structures</i></b> | <b>PGE - S08 – UE TPD</b> |
|                                                                                  |                                                                                 | 24/02/2026                |
|                                                                                  |                                                                                 | Page 2/2                  |

### Prerequisites

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- Soil mechanics program for semesters S6 and S7
- Basic knowledge of continuum mechanics
- Practical work in the MDS laboratory

### Learning Material

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- Mécanique des sols, Daniel Cordary, Paris : Tec & Doc-Lavoisier, 1994
- Éléments de mécanique des sols, François Schlosser, Presses de l'ENPC, 1997
- Geotechnical Engineering Unsaturated and Saturated Soils, Jean-Louis Briaud, Wiley, 2013
- Ouvrages et fondations en terre, Gérard PHILIPPONNAT, Bertrand HUBERT – Eyrolles, 1997
- Théorie et pratique de la géotechnique - Tome 1, Outils pour la conception des ouvrages, Claude PLUMELLE - Collection Expertise technique, 2017 ;

|                                                                                  |                                      |                           |
|----------------------------------------------------------------------------------|--------------------------------------|---------------------------|
|  | <b>Roadway structures and sizing</b> | <b>PGE - S08 – UE TPD</b> |
|                                                                                  |                                      | 24/02/2026                |
|                                                                                  |                                      | Page 1/2                  |

**Teaching Language : English**

**Number of Hours : 27h**

(Lectures: 12 h – Practical Work: 10 h – Project: 5 h)

### **Course Description and Assignments**

The course “**Pavement Structures and Design**”, part of the “**Decarbonized Public Works**” thematic track within the “**Roads and Highways**” teaching unit, enables future ESTP engineers to acquire the skills required for the design of pavement structures and to master the techniques and methods used in road construction.

The objective of the course is to introduce students to:

#### **Pavement Structures: (9 h Lectures; 5 h Project)**

- The role of roads as communication routes within the transport economy
- The classification of roads in France
- Earthworks: Embankments and subgrade layers – Specific soil classification (GTS), Conditions for the use of embankments (GTR), Conditions for the use of subgrade layers, Soil treatment
- Basic materials: Aggregates, hydraulic binders, and conventional hydrocarbon binders
- Finished materials: GNT (Grave Non Traitée – untreated granular materials), MTLH (Hydraulically Bound Materials), and hot-mix asphalt
- The different types of pavement structures: Pavement design principles, relationship between design choices and road network management
- Manufacturing and implementation of pavement structures: Construction of the subgrade, construction of the pavement body depending on material types, and site acceptance procedures

#### **Design: (3 h Lectures + 10 h Practical Work)**

- The different types of pavements
- Mechanisms of structural deterioration
- Principles of mechanical design (calculated stresses and allowable stresses)
- Mechanical modeling of pavements and representation of loads
- The concept of equivalent axles (reference axle load of 13 tonnes)
- Adjustment coefficients
- Frost verification of a pavement structure
- Use of the Alizé design software through practical case studies

**Assessment** will be based on a **Practical Work grade** and a **Project grade**.

#### **Learning Outcomes**

*[Bloom Taxonomy Level] - échelle de 1 à 6*

At the end of this course, the engineering student will be able to:

- [4] Analyze the behavior and performance of a pavement structure
- [6] Assess the importance of roads within the transport economy
- [3] Identify the materials that make up pavements
- [4] Explain the role of the different pavement layers and describe their characteristics
- [3] List the equipment used in road construction
- [5] Formulate the basic assumptions required for pavement design
- [5] Perform an informed pavement design using Alizé

ESTP

*Non-contractual document - May change*

|                                                                                  |                                      |                           |
|----------------------------------------------------------------------------------|--------------------------------------|---------------------------|
|  | <i>Roadway structures and sizing</i> | <b>PGE - S08 – UE TPD</b> |
|                                                                                  |                                      | 24/02/2026                |
|                                                                                  |                                      | Page 2/2                  |

## Prerequisites

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- Materials course
  - Construction materials engineering course
  - Knowledge of the characteristics of road construction materials (bituminous mixtures, hydraulically bound materials)
  - Earthworks and environment course
  - Road Innovation course

## Learning Material

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- Norme NF P 98-086 « Dimensionnement structurel des chaussées routières - Application aux chaussées neuves » (mai 2019) ;
- Guide technique : « Conception et dimensionnement des structures de chaussées » (décembre 1994).
- Guide de Terrassement Routier (GTR)

|                                                                                  |                    |                           |
|----------------------------------------------------------------------------------|--------------------|---------------------------|
|  | <b>Road layout</b> | <b>PGE - S08 – UE TPD</b> |
|                                                                                  |                    | 24/02/2026                |
|                                                                                  |                    | Page 1/1                  |

**Teaching Language: English**

**Number of hours: 21 h**

(Lectures: 9 h – Project: 10 h – Evaluation: 2 h + project grade)

### Course Description and Assignments

The course « **Road Alignment Design** » part of the « **Decarbonized Public Works** » thematic track within the “**Roads and Highways**” teaching unit, enables future ESTP engineers to acquire the skills required for road alignment design (horizontal alignment, longitudinal profile, cross-sections, various design elements, and earthwork volume calculations).

The main topics covered include:

- General information on roads: types, categories, technical guides,
- Plan Layout
- Cross profile
- Volume calculations
- Visibility
- Layouts of at-grade intersections
- Layouts of roundabouts
- Horizontal signage

**The assessment** will be based on a **final exam (2 hours) plus a project grade.**

### Learning Outcomes

At the end of this course, the engineering student will be able to:

- [5] Identify the types of roads;
- [4] Use technical guides for road alignments;
- [4] Conduct a road alignment study (plan layout, longitudinal profile, cross-section);
- [4] Calculate earthwork volumes (cut and fill);
- [4] Use road design software;
- [3] Design the layout of intersections and roundabouts;
- [2] Ensure safety for road users (visibility and horizontal signage).

### Prerequisites

- Geotechnical Engineering 1 course.
- Materials Science course.
- Soil Mechanics course.

### Learning Material

- Guides techniques « SETRA– LCPC
- Fascicule du CCTG – Travaux
- ARP 1994 Aménagement des Routes Principales (sauf les autoroutes et routes express)
- ICTARN (Instruction des Conditions Techniques d’Aménagement des Routes Principales)
- ICTAAL 1985 (Instruction sur le Conditions Techniques d’Aménagement des Autoroutes de Liaison)
- ICTAVRU 1990 (Instruction sur les Conditions Techniques d’Aménagement des Voies Rapides Urbaines)

|                                                                                  |                                              |                           |
|----------------------------------------------------------------------------------|----------------------------------------------|---------------------------|
|  | <b>Calculation of hyperstatic structures</b> | <b>PGE - S08 - UE TPD</b> |
|                                                                                  |                                              | 24/02/2026                |
|                                                                                  |                                              | Page 1/2                  |

**Teaching Language: English**

**Total Hours: 22 h**

(Lectures: 12 h – Tutorials: 5 h – Practical Work: 3 h – Evaluation: 2 h)

### **Course Description and Assignments**

The course « **Analysis of Statically Indeterminate Structures** », part of the « **Decarbonized Public Works** » thematic track within the “Infrastructure” teaching unit, enables future ESTP engineers to acquire the skills needed for structural analysis by providing additional knowledge to the Strength of Materials course. It allows them to develop the ability to calculate internal forces in common statically indeterminate structures that structural engineers are required to design, analyze, and verify throughout their careers.

The following topics are covered:

- Calculation of influence lines for statically indeterminate straight beams
- Three-moment equation method
- Force method
- Displacement method
- Frame analysis using the rotation method – fixed joints only, with an introduction to the method for frames with movable joints
- Frame analysis using the cut method
- Introduction to second-order instabilities and torsion

#### **Lecture 1: Introduction to the study of hyperstatic**

Reminder of sign conventions, internal force diagrams, Three Moments Theorem

#### **Tutorial 1 : Analysis of a 4-span concrete bridge deck using the Three-Moment Method**

Apply the three-moment method to an existing structure

#### **Lecture 2 : Influence lines and energy methods for hyperstatic structures**

Hyperstatic influence lines

Review of energy theorems (Castigliano / Bertrand de Fondiviolant)

Review of energy theorems (Castigliano / Bertrand de Fondiviolant)

#### **Tutorial 2 : Construction of influence lines using structural software (in the computer lab)**

Use structural software (RDM7 or ST1 v4) to understand the principle of influence lines

#### **Lecture 3 : Rotation Methods**

Fixed-node rotation methods, introduction to movable nodes and the Hardy-Cross method

Question session on points not understood from sessions 1-2

#### **Tutorial3 : Calculation of a portal frame bridge using the fixed-node rotation method**

Apply the rotation method to the new PIPO project of a small valley in Nice

#### **Lecture 4: Second-order instabilities of 1D elements.**

Calcul Isostatic / generic buckling calculation

Rankine method

Calculation under pure torsion without warping.

Preparation for the final exam: Questions and answers / Exercises.

|                                                                                  |                                              |                           |
|----------------------------------------------------------------------------------|----------------------------------------------|---------------------------|
|  | <b>Calculation of hyperstatic structures</b> | <b>PGE - S08 - UE TPD</b> |
|                                                                                  |                                              | 24/02/2026                |
|                                                                                  |                                              | Page 2/2                  |

## Learning Outcomes

*[Bloom Taxonomy Level] – scale from 1 to 6*

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At the end of this course, the engineering student will be able to:

- [3] Solve any configuration of hyperstatic and complex structures incorporating fixed and/or movable loads.
- [3] Establish the equilibrium conditions of systems taking deformations into account;
- [4] Analyze and calculate instabilities in columns and bars (buckling);
- [4] Analyze instabilities in beams (lateral-torsional buckling);
- [3] Calculate sectioned beams in bending with and without torsion.

## Prerequisites

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The skills required to take this course are as follows:

- Cours Mathematics courses;
- MMC courses;
- RDM courses: determination of the types of structures, the fundamental principle of statics, the concept of rigidity (E. IGz), calculation of structural deformations by moment integration, plotting the deformation shapes.

## Learning Material

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- Albigès & Coin : « Résistance des matériaux appliquée » (2 volumes) - Edition Eyrolles
- S.P Timoshenko : « Résistance des Matériaux » - (2 volumes) Editions Dunod
- J. Courbon : « Résistance des Matériaux » - (2 volumes) Editions Dunod
- GAY D. & GAMBELIN J. Dimensionnement des structures
- CAPRA A. & DAVIDOVICI V. Calcul dynamique des structures en zone sismique

|                                                                                  |                              |                           |
|----------------------------------------------------------------------------------|------------------------------|---------------------------|
|  | <b>Reinforced Concrete 2</b> | <b>PGE - S08 - UE TPD</b> |
|                                                                                  |                              | 24/02/2026                |
|                                                                                  |                              | Page 1/1                  |

**Teaching Language: English**

**Number of hours:** 18.5 h

(Lectures: 9 h – Tutorials: 7.5 h – Evaluation: 2 h)

## Course Description and Assignments

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### Course Description and Evaluation Methods

The course « Reinforced Concrete 2 » part of the thematic track « **Decarbonized Public Works** » within the teaching unit “*Structural Analysis and Civil Engineering Structures*”, follows the core course on reinforced concrete. It begins with a review of basic load cases and relevant regulations (EC0, EC1 & EC2), then covers the design principles of reinforced concrete structures for public works and elementary structures subjected to combined loading.

Main topics covered:

- Continuous beam calculations (according to French AN standards)
- Interaction & buckling diagrams
- Combined bending ULS and SLS

**The evaluation** will be based on a **final exam (2 hours)**.

### Learning Outcomes

*[Bloom Taxonomy Level] – scale from 1 to 6*

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At the end of this course, the engineering student will be able to:

- [3] Calculate structural elements under combined loads;
- [3] Design and reinforce deep foundations and retaining structures;
- [3] Apply construction provisions for steel in complex structural elements.

### Prerequisites

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- Le The course on regulations and Eurocode.
- The course on mechanics of materials.
- The reinforced concrete course S7.

### Learning Material

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- NF EN 1992 Eurocode 2 et annexe nationale
- FD P18-717 Guide d'application de l'Eurocode 2
- Aide-mémoire de béton armé – (A BURY) – éditions DUNOD

|                                                                                  |                             |                           |
|----------------------------------------------------------------------------------|-----------------------------|---------------------------|
|  | <b>Sizing of structures</b> | <b>PGE - S08 - UE TPD</b> |
|                                                                                  |                             | 24/02/2026                |
|                                                                                  |                             | Page 1/1                  |

**Teaching Language : English**

**Number of hours : 19 h**

(Lectures : 12 h - Tutorials: 5 h - Assesement: 2 h)

### Course Description and Assignments

The metal construction 2, of the thematic path « **Decarbonized Public Works** » The 'Infrastructures' teaching unit should enable the sizing of civil engineering structures in steel, including small buildings and more complex structures, by applying the rules of Eurocode 3. This module covers the following concepts:

- Operation of a metal framework: Review of the principles of sizing at limit states, service limit states, ultimate limit states, verifications to be carried out, design elements of a metal framework, path of vertical loads, path of horizontal loads due to wind.
- Section verification: Main characteristics of steel, Presentation of steel products, Plasticity, Section classes according to local buckling risks, Verification of sections subjected to simple and combined stresses.
- Buckling: Review of the concept of instability; Buckling equations, Euler's critical load, buckling length; Verification according to Eurocode 3: buckling curves; Calculation of the buckling lengths of a frame column.
- Beam instabilities: Lateral-torsional buckling, Local buckling. • Connections: Connection concept: displacements, connecting forces, joint rigidity, Verification principles, Welded connections, Ordinary bolted connections, Prestressed bolted connections, Connection design and construction details.

**The assessment** will be based on a **final exam (2 hours)**.

### Learning Outcomes

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to::

- [4] Describe the functioning of a metal structure, the behavior under the effect of vertical and horizontal loads, and identify the bracing elements;
- Size a frame member for serviceability limit states according to Eurocode 3;
- [4] Size a frame member for ultimate limit states according to Eurocode 3;
- [3] Perform checks on slender members for instabilities (buckling, lateral-torsional buckling, warping);
- [3] Check and design a metal connection.

### Prerequisites

- Le The course on continuum mechanics.
- Structural steel construction 1.

### Learning Material

- Eurocode 3. Calcul des structures en acier. Partie 1-1 : Règles générales et règles pour les bâtiments.
- Eurocode 3. Calcul des structures en acier. Partie 1-8 : Calcul des assemblages.

|                                                                                  |                                               |                           |
|----------------------------------------------------------------------------------|-----------------------------------------------|---------------------------|
|  | <b>Bridge design and prestressed concrete</b> | <b>PGE - S08 - UE TPD</b> |
|                                                                                  |                                               | 24/02/2026                |
|                                                                                  |                                               | Page 1/1                  |

**Teaching Language: English**

**Number of hours:** 15,5 h

(Lectures: 9 h; Tutorials: 5h-Assesement: 1,5 h)

### Course description and assessment

This course aims to complement the knowledge acquired in the prestressed concrete module of the core curriculum.

It covers the following concepts:

- The main design principles of bridges,
- The different types of bridges (standard structures, large concrete structures, metal and composite structures, etc.)
- Calculation of hyperstatic beams at the serviceability limit state
- Calculation at the Ultimate limit states
- Shear strength of prestressed concrete structures
- General construction arrangements, prestressing distribution area, general principles of cable arrangement for launched bridges and cantilever-built bridges

**The assessment** will be based on a **final exam (1.5 hours)**

### Learning outcomes

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [2] Describe the specific functioning of prestressed concrete structures
- [2] Distinguish what differentiates the behaviour of prestressed concrete structures from that of reinforced concrete structures.
- [3] Calculate hyperstatic prestressed concrete systems at the cracked SLS

### Prerequisites

The skills required to take this course are as follows:

- Strength of Materials course
- Concrete Structures course
- Structural Steel course

### Learning material

- Réglementation Eurocode 2 : Calcul des structures en béton
- Mise à disposition des présentations projetées en cours
- Y. Guyon : Béton Précontraint, études théorique et expérimentale Tomes 1 et 2, collection de l'institut du Bâtiment et des travaux publics Editions Eyrolles.
- *Eurocode 2 : Guide méthodologique d'application aux ponts routes en béton* – Edition SESTRA Ouvrage édité par le SETRA décrivant de façon détaillée et pratique les justifications aux Eurocodes d'un ouvrage d'art.
- Procédés de précontrainte : consultables et téléchargeables sur les sites des différentes sociétés distribuant la précontrainte : Freyssinet, Etic, DSI, Spie, Précontrainte, BBR etc.

|                                                                                  |                             |                           |
|----------------------------------------------------------------------------------|-----------------------------|---------------------------|
|  | <b>Ecology of materials</b> | <b>PGE - S08 – UE TPD</b> |
|                                                                                  |                             | 24/02/2026                |
|                                                                                  |                             | Page 1/2                  |

**Teaching Language : English**

**Number of hours : 21 h**

(Lectures: 12 h – Tutorials: 5 h - Laboratory work: 3 h – Evaluation: 1 h and lab grade)

### **Course Description and Assignments**

The course « **Eco-Materials** », part of the thematic track « **Decarbonized Public Works** » within the teaching unit “*Networks and Environments*”, enables future ESTP engineers to acquire specific and multidisciplinary skills related to the properties of alternative materials used in road engineering, quality control during implementation, as well as the technical, environmental, and durability assessment of concretes.

The first part of the module covers:

(Lectures: 3 h – Tutorials: 5 h – Laboratory work: 3 h – Evaluation: 1 h)

- Review of traditional pavement materials (components and mixtures)
- Cold-mix asphalts and methods for lowering manufacturing and laying temperatures (bitumen emulsion)
- Recycling and reuse of bituminous mixes (technical aspects: characterization and formulation)

**Lab work (3 h):** Formulation of an alternative material for use in road engineering.

### **Second part of the module**

(Lectures: 9 h)

- Alternative materials: recycling of various materials such as construction waste, plastics, and used tires in road construction — characterization, modification processes, operating procedures, formulation, and performance.
- Biomaterials: recycling of various biomaterials such as lignin, biochar, etc., in road construction — characterization, formulation, operating procedures, and performance
- Environmental impact assessment

**Assessment** is based on a final written exam (1 h) and a laboratory grade.

### **Learning Outcomes**

*[Bloom Taxonomy Level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [5] Understand the issues and strategy of alternative materials in road engineering;
- [4] Master the physical and mechanical properties of alternative materials;
- [4] Explain the choice of alternative materials in road engineering;
- [5] Be able to characterize materials in road engineering and know the fields of application and implementation;

### **Prerequisites**

- Construction materials engineering course
- Soil mechanics course

|                                                                                  |                             |                    |
|----------------------------------------------------------------------------------|-----------------------------|--------------------|
|  | <i>Ecology of materials</i> | PGE - S08 – UE TPD |
|                                                                                  |                             | 24/02/2026         |
|                                                                                  |                             | Page 2/2           |

## Learning Material

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- Guide méthodologique CEREMA (2021) : Recyclage des agrégats d'enrobés dans les mélanges bitumineux à chaud
- Guide technique CEREMA : Matériaux bitumineux coulés à froid
- Guide technique IDRRIM : enrobés à l'émulsion de bitume fabriqués en usine

|                                                                                  |                                          |                           |
|----------------------------------------------------------------------------------|------------------------------------------|---------------------------|
|  | <b>Water development and environment</b> | <b>PGE - S08 – UE TPD</b> |
|                                                                                  |                                          | 24/02/2026                |
|                                                                                  |                                          | Page 1/1                  |

**Teaching Language: English**

**Number of hours:** 15,5 h

(Lectures: 5 h; Tutorials: 5 h – Assessment: 1,5 h)

### **Course Description and Assignments**

The course « **Water Ecology, Recovery, Stormwater Network** », part of the thematic track « **Decarbonized Public Works** », within the teaching unit « **Circular Economy, Networks and Environments** », is a course that enables future ESTP engineers to acquire the necessary skills in integrated stormwater management and to design retention solutions.

The main concepts covered are:

- Stormwater management structures: functions, types
- The principles of designing these structures

**The evaluation** will be based on a **final test (1.5 hours)**.

### **Learning Outcomes**

*[Bloom Taxonomy Level] -scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [4] Understanding the regulatory and normative context of stormwater management
- [4] Know the types of stormwater management structures
- [3] Understand the design principles of stormwater management structures
- [4] Preliminary sizing
  - a stormwater network (mechanically and hydraulically),
  - stormwater infiltration surfaces,
  - stormwater storage volumes, as well as any associated regulations to ensure drainag

### **Prerequisites**

- Strength of Materials (S6)
- Geotechnics (S7)
- Planning and Various Networks (S5)
- Fluid Mechanics and Hydraulics (S6)

### **Learning Material**

- Booklet 70-1: Supply, installation, and rehabilitation of open-channel water pipelines
- Booklet 70-2: Works for the collection, storage, and discharge of rainwater.

|                                                                                  |                       |                               |
|----------------------------------------------------------------------------------|-----------------------|-------------------------------|
|  | <b>Maritime works</b> | <b>PGE - S08 – UE TPD ECR</b> |
|                                                                                  |                       | 24/02/2026                    |
|                                                                                  |                       | Page 1/1                      |

**Teaching Language: English**

**Number of hours: 15 h**

**(Lectures: 9 h; Tutorials: 5 h- Assesement: 1,5 h)**

### **Course Description and Assignments**

The course « Maritime Works, » part of the thematic track « Decarbonized Public Works », within the teaching unit "Infrastructure," is a course that allows future ESTP engineers to acquire the necessary skills for the design of protective port structures and quays.

A theoretical introduction will be presented for each lecture to cover the various concepts of designing maritime and port structures. The construction techniques for these structures in a marine environment will also be detailed.

The main concepts covered are:

- Design of coastal and port protection structures (vertical dikes, sloping dikes)
  - Introduction to meteorological and oceanic conditions (swells, water levels, currents...) and environmental constraints specific to maritime and port structures
  - Concepts of port operation (site layout)
  - Comparisons between vertical and sloped dikes
  - Hydraulic stability of dikes
  - Assessment of crossings
  - Associated construction methods;
- Design principles of docking and operational structures (quays) & associated execution methods

**The evaluation** will be based on a **final test (1.5 hours)**.

### **Learning Outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

At the end of this course, the engineering student will be able to:

- [4] Design maritime protection structures taking into account the site conditions;
- [4] Design a vertical or sloped dike;
- [4] Know the different construction stages of a vertical dike, sloped dike, or a quay;
- [5] Know the specific features of different types of quays and their design approach;

### **Prerequisites**

- Fluid Mechanics course,
- Statistics/Probability course
- Strength of Materials course,
- Geotechnical course

### **Learning Material**

- Making available the presentations projected during classes

# ***Semester 9 – Course descriptions***

## S9 Curriculum

| S9 Curriculum / Fall semester                                           | Study hours per Teaching Unit (UE) | Study hours per course | ECTS credits | Weighting in the UE |
|-------------------------------------------------------------------------|------------------------------------|------------------------|--------------|---------------------|
| <b>Option - Nuclear Civil Engineering</b>                               | <b>280,00</b>                      |                        | <b>20</b>    |                     |
| Subjects of the option detailed below                                   |                                    | 220,00                 |              | 3                   |
| Option project                                                          |                                    | 60,00                  |              | 7                   |
| <b>Management and communication for sustainable construction</b>        | <b>80,00</b>                       |                        | <b>10</b>    |                     |
| Sustainable and ethical construction                                    |                                    | 20,00                  |              | 2                   |
| Lean management and risk prevention                                     |                                    | 20,00                  |              | 2                   |
| Leadership & communication 5                                            |                                    | 19,00                  |              | 2                   |
| Second-year internship report                                           |                                    | 1,00                   |              | 2                   |
| Intensive English & TOEIC tactics                                       |                                    | 20,00                  |              | 2                   |
| <i>French as a Foreign Language (international students) – optional</i> |                                    | 20,00                  |              |                     |
| <i>Main Foreign Language (German or Spanish) – optional</i>             |                                    | 20,00                  |              |                     |
| <i>Additional Foreign Language – optional</i>                           |                                    | 16,50                  |              |                     |
|                                                                         | <b>360,00</b>                      |                        | <b>30</b>    |                     |

ESTP

*Non-contractual document - May change*

**Teaching language: English**

**Number of hours: 20 hours**

Lectures: 6h / Workshop: 3h / Tutorials: 9h / Final assessment written: 2h

### **Course description and assessment**

The **Sustainable and Ethical Construction** module, part of the “**Sustainable Construction Management and Communication**” covers ethical corporate governance, societal dialogue, crisis management, advanced compliance, emerging technologies and economic models that support long-term sustainability through the circular economy in the construction sector.

#### **The aims of this course :**

- Understanding how ethical corporate governance works
- Teaching how to manage stakeholder relations ethically
- Learning how to manage crises or high-risk situations in the construction sector
- Optimising compliance: by integrating strategies and processes to proactively manage risks and optimise practices internally, beyond standard compliance practices
- Addressing and questioning economic models that support long-term sustainability through the circular economy.

#### **Description of teaching :**

##### **Workshop description “Sustainable Construction”:**

This subject begins with a collaborative workshop providing an overview of the current impact of the construction sector on the environment, with figures and orders of scale. Several categories of impact are addressed : climate change, resource depletion, biodiversity and health.

##### **Lecture 1: Strategies and ethical governance**

- Deploying and managing strategies (economic interests VS values and aims of actions)
- How ethical governance works in companies
- Indicators and implementation of ethical governance (recycling rate, quantity of building site waste sent to landfill, etc.)

##### **Lecture 2 : Dialogue and Risk Management**

- Communication and dialogue strategy
- Communication practices and crisis management : health crises, environmental disasters on a construction site and/or on a national scale
- The responsibility of executives in dealing with stakeholders during conflicts
- Ethics in reputation management

##### **Lecture 3 : Audit and impact assessment**

- Internal ethical audit
- Assessment of societal, environmental and numerical impacts through ethical performance indicators (equity, inclusion, human rights, regulatory compliance, social responsibility, compliance with principles and governance, transparency, publication of an annual report, fair practices, AI for operational performance in civil engineering) and limits (protection of privacy, personal data, technology watch, etc.).

##### **Lecture 4 : Circular economic models**

- The circular economic model : current situation (2025) and future challenges in the building and public works sector (construction, renovation and deconstruction)
- The roadmap and action plan at national and European level : LTECV, SNTEMEC, PEC, SEP, PAEC : short circuits, European Green Deal, European taxonomy

- Study on the possibilities of recovery and reduction of building site waste (in-situ and ex-situ recovery), through a case study (Lyon-Turin project).

The student will be assessed in a written exam at the end of the module. This exam will consist of a multiple-choice section covering the lectures (some questions may be taken from documents or articles) and a practical case study in a company.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

- [2] Defining and applying ethical corporate governance
- [3] Knowing how to communicate with stakeholders
- [5] Carrying out an internal audit
- [6] Managing a conflict or high-risk situation within a company
- [6] Proactively managing risks within a company : advanced compliance
- [6] Implementing a circular economic model within a company that supports sustainability through the circular economy

### Prerequisites

- Engineering projects, sustainable development and social responsibility - (S05)
- Project management stakeholders, issues and projects - (S05)
- Occupational health and safety (OHS) - (S06 - S08)
- Project management (S07)
- Principles of environmental regulation (RE2020) - (S07)
- Life cycle analysis of a structure : methods and tools - (S07)
- Ecological engineering - (S08)

### Bibliography and further resources

- **PNACC3 [2025]** : Plan National d'Adaptation au Changement Climatique, Ecologie.gouv.fr
- **Le Guide de la Construction Durable [2023]** : G. Bernard, F. Henry. Un ouvrage complet sur les pratiques et les enjeux de la durabilité dans la construction
- **L'éthique dans les entreprises de construction [2022]** : S. Dupuis. Analyse des défis éthiques dans le secteur de la construction
- **L'économie circulaire pour le BTP [2023]** : V. Petit, M. Leclerc. Exploration de l'application de l'économie circulaire dans la construction et le BTP.

|                                                                                  |                                              |                            |
|----------------------------------------------------------------------------------|----------------------------------------------|----------------------------|
|  | <b>Lean management &amp; Risk management</b> | <b>PGE - S09 - UE MGT3</b> |
|                                                                                  |                                              | 24/02/2026                 |
|                                                                                  |                                              | Page 1/2                   |

**Teaching language: English**

**Number of hours:**

Lectures: 6h/ Project: 3h + 9h/ ODL (As:2h)

**Course description and assessment**

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The course "**Lean Management and Risk Prevention**", a core module within the "**Management and Communication for Sustainable Construction**" teaching unit, covers the fundamental principles of industrial organization systems for construction and risk prevention management.

**Course Objectives:**

- Understand the fundamentals of Lean Management and its application to the construction sector.
- Master Lean tools and approaches applied to construction.
- Integrate risk prevention into a performance-driven approach.
- Develop change management skills to improve safety and performance.
- Apply acquired knowledge in an integrative Lean Management and Risk Prevention project.

**Lean Management Module:**

- **Introduction to Lean Management**
  - Origins: Context of the construction sector and Lean as a competitiveness factor.
  - A brief history of Lean.
- **Lean Management Tools and Approaches**
  - Key principles.
  - Lean concepts and sustainable performance (Gemba, Value Chain, Continuous Improvement, Lead Time, Value-Added and Non-Value-Added Activities, Mudasa, Sources of Non-Performance).
  - Change Management.
- **Lean Applied to Construction**
  - Introduction to DMAIC.
- **Lean Construction Tools and Methods**
  - PDCA and 5S: Workplace improvement.
  - Visual Performance Management and management rituals.
  - Collaborative Planning: The Last Planner System (LPS).
  - Value Stream Mapping (VSM).
  - Problem-solving methodology.
- **E-Learning Modules: Lean Management and Health and Safety at Work (SST) Module**

**Assessment of Learning Outcomes**

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- **Risk Prevention:** Assessment during a dedicated introductory event.
- **Lean Management:** Assessment through a final project-based exam, including a team report and an oral defense.

|                                                                                  |                                              |                            |
|----------------------------------------------------------------------------------|----------------------------------------------|----------------------------|
|  | <b>Lean management &amp; Risk management</b> | <b>PGE - S09 - UE MGT3</b> |
|                                                                                  |                                              | 24/02/2026                 |
|                                                                                  |                                              | Page 2/2                   |

## Learning outcomes

*Bloom Taxonomy level] – scale from 1 to 6*

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- [2] Describe the principles of a Lean management system.
- [3] Apply the Lean approach in the various phases of a construction project.
- [3] Use the methodological tools of Lean construction.
- [5] Prepare the steps for implementing a Lean approach on a construction site.
- [4] Analyze organizational and human levers influencing the safety culture.
- [5] Develop engaging communication strategies and proactive leadership practices.
- [6] Apply the principles of managerial responsibility and regulatory frameworks.

## Prerequisites

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- Project Management
- Leadership & Communication 1,2,3,4
- HSW

## Learning material

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- Le grand guide du Lean management – DRISS BOUAMI – Afnor – 2021
- Lean Management pour une performance solide et durable – Radu DEMETRESCOUX - 2017
- Lean Construction - Optimiser coûts, qualité, sécurité et délais en mode collaboratif – Fabien Front - 2018
- Lean Construction Management (The Toyota Way) - Shang Gao - 2016
- Le Lean management en couleurs - Brigitte Boussuat – 2022
- La fuite managériale devant la complexité : l'exemple historique du "lean management" Philippe Lorino – 2014
- <https://www.preventionbtp.fr>

|                                                                                  |                                       |                            |
|----------------------------------------------------------------------------------|---------------------------------------|----------------------------|
|  | <b>Leadership and communication 5</b> | <b>PGE - S09 - UE MGT3</b> |
|                                                                                  |                                       | 24/02/2026                 |
|                                                                                  |                                       | Page 1/2                   |

**Teaching language: English**

**Number of hours: 19h**

Lectures: 3h/ TP: 15h / ODL (As:1h)

### **Course description and assessment**

Leadership & Communication, a core course within the teaching unit “**Management and Communication for Sustainable Construction**”, focuses on managerial communication techniques.

### **Learning Objectives:**

- Understand the importance of managerial communication in the context of the construction industry.
- Identify the different types and channels of communication used in management.
- Recognize the main barriers to communication and strategies to overcome them.
- Introduce key techniques for effective communication within a project team.

### **1. Managerial Communication in the Construction Sector**

- Definition and specific features of managerial communication in the construction context (project complexity, diversity of stakeholders, importance of safety, etc.).
- Importance of communication in managing multidisciplinary teams (architects, structural engineers, secondary trades, etc.).
- Crucial role of communication in the success of technical projects (coordination, problem-solving, handling unexpected issues).
- Connection with leadership and team motivation.

### **2. Fundamentals of Managerial Communication**

- **Different types of communication:**
  - Brief overview of downward, upward, and horizontal communication with concrete examples from the construction sector (site directives, team feedback, coordination between subcontractors).
- **Communication channels:**
  - Focus on verbal communication (site meetings, briefings), written communication (reports, emails, plans), and non-verbal communication (importance of body language, active listening on site).
- **Barriers to communication:**
  - Identification of common obstacles in construction projects (technical jargon, cultural differences, stress, time constraints).
  - Introduction of simple methods to overcome them (clarifying language, adapting to the audience, creating opportunities for dialogue).

### **3. Key Techniques for Effective Communication within Project Teams**

- **Clarity and conciseness:**
  - Introduction to techniques for structuring clear and precise messages (the 5W rule, importance of key messages).
  - Quick exercises on rephrasing or simplifying technical messages.
- **Constructive feedback:**

|                                                                                  |                                       |                            |
|----------------------------------------------------------------------------------|---------------------------------------|----------------------------|
|  | <b>Leadership and communication 5</b> | <b>PGE - S09 - UE MGT3</b> |
|                                                                                  |                                       | 24/02/2026                 |
|                                                                                  |                                       | Page 2/2                   |

- Presentation of basic principles for giving and receiving constructive feedback (facts vs. judgments, impact on behavior, suggestion for improvement).
- Simple role-playing scenarios.

### Practical Work:

Workshop: Applying Managerial Communication Techniques

### Soft Skills Portfolio

The portfolio is a personal file in which the student's learning outcomes and experiential achievements are defined and demonstrated over the past academic year. The Soft Skills Portfolio (SSP) consists of two specific components:

- **LEADERSHIP AND COMMUNICATION** – How to become an ethical and responsible operational manager
- **PROFESSIONAL DEVELOPMENT** – How I Become a Responsible Professional

### Assessment of Learning Outcomes

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The assessment will be carried out in two parts:

- Evaluation during Practical Work
- Professional presentation delivered as part of the Soft Skills Portfolio

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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[2] Identify and articulate a problematic managerial communication situation experienced in a professional or associative context.

[3] Design an appropriate response to a managerial communication situation by selecting suitable channels, messages, and communication postures.

[4] Critically analyze a managerial interaction, whether oral or written, by identifying its strengths and limitations (posture, channel, register, impact).

[5] Deliver a professional presentation of a group project by adopting a coherent posture, clear communication, and an effective distribution of roles.

### Prerequisites

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- Leadership & Communication 1,2,3,4
- Intercultural Management

### Learning material

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- Structure & Dynamique des Organisations / H. Mintzberg / Les Éditions d'Organisation Paris, 1982
- Traité de psychologie de la motivation / P. Carré & F. Fenouillet / Dunod, 2009
- Travailler et faire travailler en équipe / E. Mathey & F. Merillou / Eyrolles Éditions d'Organisation, 2009
- Coachez votre équipe / P. Longin / Dunod, 2006 (3ème édition)
- Comment Manager / V. Guibert / Eyrolles Éditions d'Organisation, 2009
- Des jeux et des hommes / E. Berne / Stock, 199

## S9 Curriculum Nuclear Civil Engineering Option

| S9 Curriculum<br>Nuclear Civil Engineering Option                             | Study hours<br>per Teaching<br>Unit (UE) | Study hours<br>per course | ECTS<br>credits | Weighting in<br>the UE |
|-------------------------------------------------------------------------------|------------------------------------------|---------------------------|-----------------|------------------------|
| <b>Subjects of the Nuclear Civil Engineering Option</b>                       | <b>280,00</b>                            |                           | <b>20</b>       |                        |
| Seismic engineering for soils and structures                                  |                                          | 40,00                     |                 | 1                      |
| Design of nuclear buildings                                                   |                                          | 21,00                     |                 | 1                      |
| Nuclear safety requirements and considerations in civil works construction    |                                          | 20,00                     |                 | 1                      |
| Nuclear reactor technologies, leak-tightness monitoring and aging analysis    |                                          | 20,00                     |                 |                        |
| Advanced calculations for transient analysis and introduction to LS-DYNA code |                                          | 20,00                     |                 |                        |
| Seismic analysis and introduction to ANSYS code                               |                                          | 20,00                     |                 |                        |
| Prestressing calculations and introduction to CAST3M code                     |                                          | 21,00                     |                 |                        |
| Research and development in nuclear civil engineering                         |                                          | 19,00                     |                 |                        |
| Construction of nuclear facilities, site management and technologies          |                                          | 21,00                     |                 |                        |
| Soil-structure interactions                                                   |                                          | 18,00                     |                 |                        |
| <b>Project</b>                                                                |                                          | 60,00                     |                 | 7                      |

ESTP

*Non-contractual document - May change*

|                                                                                  |                                                     |                               |
|----------------------------------------------------------------------------------|-----------------------------------------------------|-------------------------------|
|  | <b>Seismic engineering for soils and structures</b> | <b>PGE - S09 - Option GCN</b> |
|                                                                                  |                                                     | 24/02/2026                    |
|                                                                                  |                                                     | Page 1/1                      |

**Teaching language: English**

**Number of hours: 39,5 hours**

Lectures: 24h; Tutorials: 13,5h Final assessment: 2h.

### **Course description and assessment**

Earthquake engineering of nuclear installations requires a good command of dynamics of soils and structures, because of the high level of seismic input motions, size and complexity of structures and because it is necessary to describe seismic motion transferred to those components to be seismically qualified.

The purpose of the course is first to provide with necessary knowledge and capacities those engineers who will have to deal with seismic protection of nuclear installation, and second to give him or her perspectives over this knowledge, so that he or she be able to acquire deeper knowledge if necessary or desired.

Following items are developed:

- Eigenmodes of discrete and continuous systems.
- Numerical methods for eigenmodes identification, finite elements.
- Supplements on single degree of freedom systems, response spectra.
- Seismic response of an N DoF damped system, mono or multi supported ; maximum effects of seismic input motion in the system.
- Basis of random vibration theory ; modal combination formula.
- Seismic motion transferred to equipment.

Final assessment is based on an exam in the spirit of tutorial exercises.

### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

- [2] Understand basis of dynamics of soils and structures.
- [3] Handle earthquake engineering terminology and concepts.
- [2] Be knowledgeable of seismic input motion features and understand their effects.
- [4] Understand and identify consequences of non-linear constitutive relationships.
- [4] Analyze effects of a seismic input motion on a nuclear installation.

### **Prerequisites**

Dynamics of rigid bodies.

Strength of materials.

Linear algebra, vectorial spaces.

Finite element method in static analysis.

### **Learning material**

Handbook covering all items presented in course and more.

Book « Seismic Engineering » by J. Betbeder-Matibet, ISTE-Wiley, 2008

Clough & Penzien ; Dynamics of Structures ; Mac Graw-Hill, 1975

|                                                                                  |                                    |                               |
|----------------------------------------------------------------------------------|------------------------------------|-------------------------------|
|  | <i>Design of Nuclear Buildings</i> | <b>PGE - S09 - Option GCN</b> |
|                                                                                  |                                    | 24/02/2026                    |
|                                                                                  |                                    | Page 1/1                      |

**Teaching language: French and English**

**Number of hours: 20,5 hours**

Lectures: 19.5h / Final assessment: 1h

### Course description and assessment

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This course introduces the principles and engineering methods used in the design of reinforced concrete structures for nuclear facilities. It emphasizes the role of the engineer in interpreting finite element model results and translating them into concrete reinforcement design.

Course topics include:

- From FEM to reinforcement: slab analysis using sandwich method and reinforcement determination from internal forces.
- Model limits: application of strut-and-tie models to shear walls.
- From reinforcement maps to reinforcement detailing: smoothing, peak trimming, and treatment of modeled/non-modeled openings.
- 

Assessment is based on a practical exercises submitted at the end of the module.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, the engineering student will be able to [Level 4]:

- Identify the design steps of a nuclear concrete building.
- Analyze FEM outputs.
- Propose theoretical reinforcement solutions.
- Understand and apply the limitations of FEM models.

### Prerequisites

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The prerequisites for attending this course are as follows:

- Basics in strength of materials and reinforced concrete.
- Knowledge of numerical modeling (FEM).
- Fundamentals of Eurocode 2.

### Learning material

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- ASN Guide ASN/GUIDE/2/01
- Eurocodes (EN1992-1-1, EN1990)
- RCC-CW 2018

|                                                                                  |                                                                             |                                   |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------|
|  | <b>Nuclear Safety Requirements &amp; Civil Engineering<br/>Design Rules</b> | <b>PGE - S09 - Option<br/>GCN</b> |
|                                                                                  |                                                                             | 24/02/2026                        |
|                                                                                  |                                                                             | Page 1/1                          |

**Teaching language: English**

**Number of hours: 19 hours**

Lectures: 18 hours Final assessment: 1 hour

### Course description and assessment

The objectives of the modules are to introduce the nuclear safety requirements for civil work, their impact on civil engineering design rules and the specific points to know during construction. It address the key concept in nuclear safety, the regulatory requirements, the engineering approaches linked (design, accidental and post-accidental conditions,...), the sensitive points (regarding nuclear safety) during civil work construction and specific cases.

The following notions are addressed:

- Nuclear safety requirements for civil work
- Impact of nuclear safety on the civil work design
- Regulatory requirements, including ASN 2/01 guide and RFS 2001-01
- Engineering approaches linked to nuclear safety
- Notion of design condition and accidental or incidental conditions
- Organization of a nuclear project
- Strategy to establish an inspection program
- Sensitive points during nuclear civil work construction (foundations, reinforced concrete, prestressed concrete, metallic liner)

A final test of 1 hour will be made for validation

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

- [2] Identify the safety requirement of a nuclear facility
- [2] Identify the loads to apply on a nuclear facility
- [2] Explain the impact of this requirements on the building design
- [2] Apply the design and verification principles according ASN 2/01 guide and (RFS 2001-01)
- [3] Establish an inspection strategy (prioritization of the element to inspect)
- [6] Known the sensitive points of the nuclear building works

### Prerequisites

- Structural mechanics basis
- General knowledge on civil work regulations
- Seismic behavior of civil construction
- Basis on construction materials (reinforced concrete, prestressed concrete, ...)

### Learning material

- ASN guide for "basic nuclear installation"
- Franch nuclear authority decision on tornado
- RCC-CW, Eurocode 8 – Nuclear part standards
- AIEA's publications
- Lesson medium from ESTP

|                                                                                  |                                                                               |                               |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------|
|  | <b>Nuclear reactor technology, containment monitoring and ageing analysis</b> | <b>PGE - S09 - Option GCN</b> |
|                                                                                  |                                                                               | 24/02/2026                    |
|                                                                                  |                                                                               | Page 1/1                      |

**Teaching language: English**

**Number of hours: 20h**

Lectures: 12h / Project: 2h / Tutorials: 6h

### Course description and assessment

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The "Nuclear Reactor Technology, Containment Monitoring, and Aging Analysis" course, part of the "Nuclear Civil Engineering" 3rd year option, provides future ESTP engineers with the necessary skills for designing nuclear reactor containment structures. It delivers to them the knowledge to design and verify prestressed reinforced concrete structures with an eventual internal metal skin under normal and accident conditions.

The course covers the following topics:

- Specific safety requirements and containment design criteria;
- Containment design and optimization;
- Prestressing technologies ;
- Detailed and execution study of the containment - specific technical specifications ;
- Probabilistic safety assessment (with respect to ultimate pressure) ;
- Analysis of monitoring results during testing and normal service ;
- Prediction of long-term behavior ;
- Numerical calculation of the containment in a severe accident situation ;
- Thermal effects in normal and accident situations.

The evaluation will be based on the examination of the the NC<sup>2</sup>E (Nuclear and Complex Civil Engineering) project. The teacher will appraise the report, the presentation and the answers to the questions that will be asked during the exam.

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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The main learning outcomes are targeted:

- Ability to develop various studies on containment structures over the lifespan of the power plant
- Ability to prescribe monitoring methods and to interpret the results
- Ability to predict long-term behavior considering ageing effects

### Prerequisites

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- Design of reinforced concrete structures
- Design of prestressed concrete structures
- Design of steel structures

### Learning material

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- RCC-CW 2023
- Model Code 2010
- Structural Eurocodes
- Structural Eurocodes

ESTP

*Non-contractual document - May change*

|                                                                                  |                                                                                         |                                   |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----------------------------------|
|  | <b>Advance calculations for transient analysis and<br/>introduction to LS-DYNA Code</b> | <b>PGE - S09 - Option<br/>GCN</b> |
|                                                                                  |                                                                                         | 24/02/2026                        |
|                                                                                  |                                                                                         | Page 1/1                          |

**Teaching language: English**

**Number of hours: 19.5h**

Lectures: 19.5h

### Course description and assessment

---

This module focuses on transient dynamics and impulsive loads, with an emphasis on the LS-DYNA code. It covers different types of impacts and impulsive loads, constitutive equations of concrete, and design methodologies for impact and explosion phenomena. The course includes numerical examples and practical applications using LS-DYNA. The evaluation is based on a project with a 3h00 oral defense.

The module covers the following topics:

- Definition of the domain of "fast" or transient dynamics
- Concepts of hard and soft impacts
- Behavior of concrete under fast dynamics
- Definition of load cases to be considered
- Establishment of an impact force diagram – Riera Method
- Design methodology
- Verification methodology
- Impact problem modeling on reinforced concrete structures
- Modeling with LS-DYNA
- Analysis and post-processing with LS-PrePost

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

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At the end of this course, the engineering student will be able to:

- [Level 2] Understand the principles of transient dynamics and their applications in civil engineering.
- [Level 3] Apply design methodologies for protecting structures against impacts and explosions.
- [Level 4] Model and analyze structures subjected to dynamic loads in LS-DYNA.
- [Level 5] Evaluate and appreciate the results of impact and explosion simulation.

### Prerequisites

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The prerequisites for this course are as follows :

- Fundamentals of structural dynamics
- Basics of material mechanics and reinforced concrete
- Knowledge of finite element method and numerical simulation software

### Learning material

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- LS-DYNA Theory Manual
- UFC 3-340-02 "Structures to Resist the Effects of Accidental Explosions"
- Technical documents on impact modeling and impulsive loads

|                                                                                  |                                                                             |                                   |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------|
|  | <b><i>Prestressing calculations and introduction to<br/>CAST3M Code</i></b> | <b>PGE - S09 - Option<br/>GCN</b> |
|                                                                                  |                                                                             | 24/02/2026                        |
|                                                                                  |                                                                             | Page 1/1                          |

**Teaching language: English**

**Number of hours: 21 hours**

Lectures: 6 hours / Tutorials: 12 hours / Project: 3h.

### **Course description and assessment**

This module aims to introduce students to the principles of prestressing calculations applied to the containment structures of nuclear facilities, as well as to the numerical modeling of these structures using the CAST3M finite element code. Emphasis is placed on practical aspects through the completion of a mini numerical simulation project.

#### **Part 1: Prestressing Calculations Applied to Containment Structures**

- Historical evolution of containment structures and associated prestressing systems
- Design criteria for a containment building
- Technological aspects: from bare strands to greased sheathed strands
- Case studies: EPR (Kudankulam, Olkiluoto, Flamanville), RJH

#### **Part 2: Introduction to CAST3M Code**

- General presentation of the CAST3M software
- Structure of the code: data, operators, syntax
- Preparation of the computational model (geometry, mesh, loads, boundary conditions)
- Resolution of the discretized problem
- Post-processing and interpretation of results

#### **Part 3: Practical Applications**

- Mechanical analyses: static, modal, and dynamic
- Thermal analyses: steady-state and transient regimes
- Thermo-mechanical analysis
- Nonlinear analyses

#### **Part 4: Mini Numerical Simulation Project**

- Simulation of a nuclear reactor containment structure under complex loading:
- Evaluation of concrete long-term behavior (shrinkage, creep)
- Analysis of the structure's behavior under prestressing tendon loads

The evaluation is based on a project (written report and oral defense).

### **Learning outcomes**

*[Bloom Taxonomy level] – scale from 1 to 6*

[2] Understanding of prestressing challenges in nuclear containment structures

[3] Mastery of modeling principles using a finite element code (CAST3M)

[4] Thermo-mechanical analysis of large concrete structures

[4] Ability to carry out a complete numerical study based on a real-world case

### **Prerequisites**

Rigid body dynamics

Strength of materials

Finite element method.

### **Learning material**

Handbook covering all items presented in course and more.

|                                                                                  |                                             |                               |
|----------------------------------------------------------------------------------|---------------------------------------------|-------------------------------|
|  | <b>R&amp;D in nuclear civil engineering</b> | <b>PGE - S09 - Option GCN</b> |
|                                                                                  |                                             | 24/02/2026                    |
|                                                                                  |                                             | Page 1/1                      |

**Teaching language: English**

**Number of hours: 18 hours**

Lectures: 18hours

### Course description and assessment

This module provides an overview of research and development (R&D) topics and methodologies in the field of civil engineering for nuclear infrastructures. It highlights the specific technical, safety, and performance requirements of nuclear structures, as well as the role of innovation and numerical modeling in addressing current and future challenges.

By the end of this module, students will be able to:

- Understand the strategic role of R&D in nuclear civil engineering.
- Identify key research topics and challenges in nuclear infrastructure design and safety.
- Analyze the performance of nuclear structures under extreme loading (seismic, thermal, accidental).
- Apply numerical and/or experimental approaches to assess structural behavior.

### Module Content

- Introduction to R&D in the nuclear sector
  - Regulatory context and safety challenges
  - Role of civil engineering in nuclear R&D
- Key research topics
  - Seismic behavior of nuclear structures
  - Concrete ageing and material durability
  - Containment structures and prestressing
  - Impact and extreme event resistance (aircraft crash, explosion, etc.)
  - Coupled analyses: thermo-mechanical, soil-structure interaction
- Methods and tools
  - Experimental approaches (mock-up, full-scale testing)
  - Advanced modeling techniques (FEM, nonlinear dynamics, multiphysics)
  - Codes and software tools (CAST3M, ANSYS, LS-DYNA, etc.)
  - Validation, verification, and uncertainty analysis
- Case studies and industrial projects
  - Examples from EDF, CEA, ANDRA, Ingerop, etc.
  - Innovation in new build and decommissioning contexts

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

- [2] Ability to contextualize R&D efforts within the nuclear industry
- [3] Familiarity with advanced tools and methods used in nuclear civil engineering research
- [4] Critical thinking in assessing structural performance under complex conditions
- [4] Teamwork and scientific communication skills in a research setting

### Prerequisites

Earthquake engineering,  
Finite element method.

### Learning material

Handbook covering all items presented in course and more.

|                                                                                  |                                                                                   |                                   |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------|
|  | <b>Construction of nuclear facilities, site management<br/>&amp; technologies</b> | <b>PGE - S09 - Option<br/>GCN</b> |
|                                                                                  |                                                                                   | 24/02/2026                        |
|                                                                                  |                                                                                   | Page 1/2                          |

**Teaching language: French and English**

**Number of hours: 21 hours**

Lectures: 18h, Tutorials: 3h.

### **Course description and assessment**

This module introduces the fundamentals of designing, constructing, and managing construction sites for nuclear facilities, with a strong focus on the interaction between nuclear technologies and civil engineering. It provides an overview of nuclear reactor operations, main structural and mechanical components of power plants, and the specific design and construction requirements of Generation III and III+ reactors.

Students will gain a comprehensive understanding of the technical, organizational, and regulatory constraints encountered on nuclear construction sites, including cleanliness, safety, interface management, and precision requirements.

### **Learning Objectives**

- By the end of this module, students will be able to:
- Understand the basic operation of a nuclear reactor and identify its main components
- Recognize the specific construction constraints related to PWR, BWR, and CANDU technologies
- Grasp key issues related to multi-disciplinary coordination on nuclear construction sites
- Analyze the enhanced safety and performance requirements of Generation III / III+ designs
- Understand the critical interfaces between civil works and electromechanical systems

### **Module Content**

- Introduction to Nuclear Reactor Operations
  - Nuclear energy in the global context
  - Main components of a power plant: buildings, boilers, generators
  - Structure of light water reactors: PWR and BWR
  - Basics of reactor physics: moderator, coolant, fuel
  - Principles of nuclear safety and the role of the containment structure
- Design and Construction Aspects
  - Overview of reactor technologies: impacts on civil works
  - Comparison of PWR / BWR / CANDU technologies
  - Documentation and regulatory requirements
  - Installation in confined environments (bunkers)
  - Planning and coordination of civil works vs. electromechanical systems
  - Critical interfaces between civil engineering and equipment
  - Specific requirements: metal liners, spent fuel pools, concrete finishes, cleanliness
  - Containment building pressure test
- Specific Features of Generation III / III+ Reactors
  - Extended service life requirements ( $\geq 60$  years)
  - Aircraft crash resistance: double-shell containment
  - Enhanced seismic resistance
  - Containment integrity: protection against internal and external hazards
  - Integration of core catcher systems

|                                                                                  |                                                                                   |                                   |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------|
|  | <b>Construction of nuclear facilities, site management<br/>&amp; technologies</b> | <b>PGE - S09 - Option<br/>GCN</b> |
|                                                                                  |                                                                                   | 24/02/2026                        |
|                                                                                  |                                                                                   | Page 2/2                          |

### Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

- [2] Understand reactor operation and nuclear safety principles
- [3] Identify construction and interface constraints on nuclear sites
- [4] Analyze the specific features of Generation III / III+ technologies
- [5] Anticipate the main construction challenges in constrained environments

### Prerequisites

Basic knowledge of civil engineering  
General understanding of nuclear reactor physics (recommended)  
Introduction to nuclear facilities

### Learning material

Handbook covering all items presented in course and more.

|                                                                                  |                                   |                               |
|----------------------------------------------------------------------------------|-----------------------------------|-------------------------------|
|  | <i>Soil structure interaction</i> | <b>PGE - S09 - Option GCN</b> |
|                                                                                  |                                   | 24/02/2026                    |
|                                                                                  |                                   | Page 1/1                      |

**Teaching language: English**

**Number of hours: 18h**

Lectures: 7h30 / Tutorials: 1h30

Part A. Transfert des spectres (3h)  
Part B. Introduction à l'interaction sol-structure (4h30)  
Part C : TD n°1 (1h30)  
Part D : TD n°2 (1h30)

## Course description and assessment

Brief description of the content of the intervention :

- Part A: Problem motivation (30')  
Problem definition and solution methodologies (1h30)  
Presentation of software tools for transfer of floor response spectra (30')  
Presentation of a real application (30')
- Part B: Soil-structure interaction: definition and basic notions (1h)  
Methodologies for taking into account SSI (1h)  
Foundation impedance (1h)
- Part C: Exercise (Tutoring) (1h30)
- Part D: Exercise (Tutoring) (1h30)

Evaluation :

- Students will need to complete an exercise on the transfer of spectra and an exercise on soil-structure interaction during the two sessions.
- Homework assignment (to be confirmed): prepare a homework on soil-structure interaction (it could be a not-too-difficult exercise referring to a real structure).

## Learning outcomes

*[Bloom Taxonomy level] – scale from 1 to 6*

- Introduction to the fundamental concepts of soil-structure interaction
- Purpose and development of response spectra

## Prerequisites

- Fundamental principles of structural dynamics
- Fundamental principles of geotechnics

## Learning material

- Handout including the theory and applications taught, along with their solutions
- PowerPoint presentations for the three sessions