UCLouvain

lgciv2033

2025

Steel and composite steel-concrete structures

The version you're consulting is not final. This course description may change. The final version will be published on 1st June.

5.00 credits	30.0 h + 30.0 h	Q1

Teacher(s)	Charlier Marion ;Vassart Olivier ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	It is advised to have a grounding in the fundamental concepts of material resistance, structural mechanics and concrete structures, as taught in LGCIV1031, LGCIV1022, LGCIV1023, LGCIV1032
Main themes	Characteristics of steel and durability, design of steel frames, dimensioning calculation requirements, welded and bolted connections, composite steel-concrete structures, fatigue, fire resistance design.
Learning outcomes	**At the end of this learning unit, the student is able to :** With reference to the AA baseline of the "Master in Civil Engineering" program, this course contributes to the development, acquisition and evaluation of the following learning outcomes: AA1.1, AA1.2, AA1.3, AA2.1, AA2.3, AA5.4 At the end of this course, the student must be able to apply some specifications of Eurocodes 3 (EC3) and 4 (EC4) and in particular be able to: STEEL PART: • Describe the characteristics of structural steel, how it is made and its various designations; • Understand and apply the general rules of frame design: bracing, expansion joints, descent of loads, flow of forces from their point of application to the foundations, classification of frames, influence of the choice of the structural system on the transmission of loads in the frames; • Understand and apply the notions of section of classes as described in EC3; • Control the dimensioning criteria and the calculation according to the EC3 of the metallic elements subjected to simple tension, simple compression, simple bending, composed bending, biaxial bending and deflected bending (taking into account the buckling and lateral torsional bucking); • Design simple joints, welded and/or bolted connections according to the criteria defined in EC3 and understand the mechanisms of failure involved in beam-to-beam, beam-column assemblies under various loads; 1 COMPOSITE STEEL-CONCRETE PART: • Know and knowingly choose the fundamental assumptions that govern the calculation of a composite beam, a composite column and a composite floor; • Calculate the normal plastic strength of a composite column and the resistant plastic moment of a composite beam; FATIGUE PART: • Master the principles of the calculation of fatigue strength in steel structures using the concept of cumulative damage with or without consideration of the fatigue limit. FIRE RESISTANCE PART: • Restore and apply the Eurocode approaches concerning the calculation of thermal actions in metallic and composite structures; • Explain how to evaluate the mechanical behavior of a steel structure in case of fire.
Evaluation methods	Written exam in two parts PART 1: theoretical part PART 2: exercises (form with main equations provided)
Teaching methods	The support of the courses is a slides deck, in English. The exercises sessions are undertaken with the support of a teaching assistant. The answers are provided to the students.

Content	Chapter 1: Steel material properties & steel production • How steel is made: Primary and secondary steelmaking, Rolling • Mechanical properties: Resistance, Grains, Toughness, Chemical components, Steel grades, Application examples Chapter 2: Design of steel elements • Classification of sections • Elements in tension • Elements in compression • Elements subjected to bending (and bi-axial bending) • Elements subjected to bending and tension • Elements subjected to bending and compression • Elements in bending and compression Chapter 3: Steel-Concrete composite structures • Introduction to composite action • Advantages & drawbacks, field of application • Composite Slabs • Composite Beams • Composite Columns Chapter 4: Steel connections • Properties and classification of the welds, resistance criteria for welds under tension, shear and combined loads • Basic calculation of simple welded connections • Properties and classification of the simple and prestressed bolts, resistance criteria for bolts under tension, shear and combined loads • Resistance of the connected elements • Design principles of moment resisting connections, basics of stiffness, resistance, rotation capacity, semi-rigid connections. Chapter 5: The decarbonization of steel and the environmental impact of Structures through LCA (Life Cycle Assessment) • Low carbon materials: a focus on steel • Environmental Product Declarations (EPD) • Life-Cycle-Assessment (LCA) • The importance of the design optimization • Circularity Chapter 6: Fire resistance • Thermal analysis, heating of composite steel-concrete elements, mechanical hot resistance, general principles of a « fire design » of a steel and steel-concrete structure ; • Practical means of protection against fire Chapter 7: Design of steel frames • Modelling and simplifying assumptions ; • Bracings and dilatation joints; • Design of one storey structures (type « hall » - monovolumes) ; • Classification of frames.
Inline resources	Moodle UCL website including the slides of the courses, resolved exercises and other useful documents. https://moodle.uclouvain.be/
Bibliography	• En français : Traité de Génie Civil de l'Ecole polytechnique de Lausanne : volumes 10 et 11. • En anglais, publications de l'ECCS (= European Convention for Constructional Steelwork)
Other infos	Visit of a steel plant, a steel workshop and/or a building site following the opportunities.
Faculty or entity in charge	GC

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Civil Engineering	GCE2M	5		🔍
Master [120] in Architecture and Engineering	ARCH2M	5		🔍