

COURSE DESCRIPTION

1. GENERAL INFORMATION

GENERAL INFORMATION			
SCHOOL	CIVIL ENGINEERING		
DEPARTMENT			
EDUCATION LEVEL	Undergraduate		
COURSE CODE	1139	SEMESTER	8
COURSE TITLE	STEEL STRUCTURES III		
COURSE UNITS		HOURS	ECTS CREDITS
σε περίπτωση που οι διδακτικές απονέμονται σε διακριτά μέρη του μαθήματος π.χ. Διαλέξεις, Εργαστηριακές Ασκήσεις κ.λπ. Αν οι διδακτικές απονέμονται ενιαία για το σύνολο του μαθήματος αναγράφεται εβδομαδιαίες ώρες διδασκαλίας και το σύνολο των διδακτικών μονάδων / ECTS			
Lectures and Exercises		3	4
Προσθέστε σειρές αν χρειαστεί. Η οργάνωση διδασκαλίας και οι διδακτικές μέθοδοι που χρησιμοποιούνται περιγράφονται αναλυτικά στο 4.			
COURSE TYPE:	ELECTIVE		
Γενικού Υποβάθρου, Ειδικού Υποβάθρου, Ειδικότητας			
PREREQUISITE KNOWLEDGE:			
COURSE AND EXAMS LANGUAGE:	GREEK		
COURSE OFFERED TO ERASMUS STUDENTS:	No, because attendance is impossible without knowledge of the Greek language.		
COURSE WEBSITE (URL):	https://helios.ntua.gr/course/view.php?id=1586		

2. LEARNING OBJECTIVES

Learning Objectives <i>Περιγράφονται τα μαθησιακά αποτελέσματα του μαθήματος οι συγκεκριμένες γνώσεις, δεξιότητες και ικανότητες καταλλήλου επιπέδου που θα αποκτήσουν οι φοιτητές μετά την επιτυχή ολοκλήρωση του μαθήματος.</i> <i>Συμβουλευτείτε το Παράρτημα Α</i> - Περιγραφή του Επιπέδου των Μαθησιακών Αποτελεσμάτων για κάθε ένα κύκλο σπουδών σύμφωνα με Πλαίσιο Προσόντων του Ευρωπαϊκού Χώρου Ανώτατης Εκπαίδευσης - Περιγραφικοί Δείκτες Επιπέδων 6, 7 & 8 του Ευρωπαϊκού Πλαισίου Προσόντων Διά Βίου Μάθησης και Παράρτημα Β - Περιληπτικός Οδηγός συγγραφής Μαθησιακών Αποτελεσμάτων
With the successful completion of the course the students: - Will have acquired appropriate knowledge to: - o Evaluate the analysis methods proposed by the EC3 and EC9 for the structural design of steel and aluminium structures. - o Understand the theoretical background of strength verification checks for structures made of stainless steel and aluminium. - o Evaluate the mechanical behaviour of steel joints. - o Identify solutions from scientific literature regarding the calculation of member resistances against buckling when applying the equivalent member method for various structural arrangements. - o Evaluate the mechanical behaviour of built-up members. - Will have acquired appropriate skills to: - o Select and apply the appropriate analysis method for a structure according to EC 3 and 9. - o Perform analyses with second-order effects for the economical and safe design of metal structures. - o Execute strength verification checks for members and cross-sections made of alternative metal

materials such as stainless steel and structural aluminium, taking into account their special mechanical behaviour.

- o Properly design joints to ensure adequate seismic behaviour and the desired mechanical behaviour regarding moment bearing behaviour (moment-resisting connections, pinned connections, etc.).
- o Calculate critical buckling loads for the elements of the structural system depending on support conditions and the influence of adjacent structural elements, as well as the specifics of the system's geometry.
- o Utilize modern software for the design of metal structures, applying their new knowledge.
- They will have acquired appropriate abilities to:
 - o Design metal constructions and built-up members, from steel or non-conventional materials, through nonlinear finite element analyses, analytical relationships, and combinations thereof."

General abilities

Λαμβάνοντας υπόψη τις γενικές ικανότητες που πρέπει να έχει αποκτήσει ο πτυχιούχος (όπως αυτές αναγράφονται στο Παράρτημα Διπλώματος και παρατίθενται ακολούθως) σε ποια / ποιες από αυτές αποσκοπεί το μάθημα;.

Αναζήτηση, ανάλυση και σύνθεση δεδομένων και πληροφοριών, με τη χρήση και των απαραίτητων τεχνολογιών

Προσαρμογή σε νέες καταστάσεις Λήψη αποφάσεων

Αυτόνομη εργασία Ομαδική εργασία

Εργασία σε διεθνές περιβάλλον

Εργασία σε διεπιστημονικό περιβάλλον

Παράγωγή νέων ερευνητικών ιδεών

Σχεδιασμός και διαχείριση έργων

Σεβασμός στη διαφορετικότητα και στην πολυπολιτισμικότητα Σεβασμός στο φυσικό περιβάλλον

Επίδειξη κοινωνικής, επαγγελματικής και ηθικής υπευθυνότητας και ευαισθησίας σε θέματα φύλου

Άσκηση κριτικής και αυτοκριτικής

Προαγωγή της ελεύθερης, δημιουργικής και επαγωγικής σκέψης

- Search, analysis and synthesis of data and information, using the necessary technologies
- Adaptation to new situations
- Decision making
- Autonomous work
- Teamwork
- Work in an international environment
- Generating new research ideas
- Project planning and management
- Respect for the natural environment
- Demonstrating social, professional and ethical responsibility and sensitivity to gender issues
- Exercise criticism and self-criticism
- Promotion of free, creative and inductive thinking

3. COURSE DESCRIPTION

Alternative design methods

Introduction, selection of the appropriate analysis method according to the new generation of EC 3, material and geometric non-linearities, stability loss, global frame imperfections and local member imperfections, simulation of imperfections of steel structures, classification of cross-sections into buckling categories, practical examples.

Calculation of critical buckling loads

Introduction – Flexural buckling, isolated members and frames with negligible lateral displacement, continuous members with constant flexural stiffness, intersecting members, isolated members and frames with lateral displacement, bridge members and networks, elastically supported compressed members - Torsional and torsional- flexural buckling, members of open cross-sections with point, single or double symmetry, members of open single-symmetric cross-sections, members of nonsymmetric cross-sections, members with continuous lateral support and beams on elastic ground - Lateral torsional buckling, beams with doubly symmetric cross-sections, beams with single-symmetric cross-sections - boundary conditions, spring stiffness and continuous elastic supports, scissor support conditions, I cross-sections with discrete intermediate torsional supports, lateral supports against lateral torsional buckling, beddings and continuous elastic supports.

Special Issues in the design of steel joints

EC 3-1-8 Node Design, bolt resistances, equivalent stab method T - Design of moment-resisting connections, design resistance of beam-to-column or beam-to-beam connections, welds, calculation of joint torsional stiffness, rotational capacity of joint, design resistances - Design of nominally pinned connections, ductility and rotational capacity, base plate design, seismic design of steel building connections, design resistances node, detachment – Column base design, column base with anchors,

column base with bolts - EC 8-1-2, Annex E, seismic design of steel building connections, composite joints, plastic hinge positions, design resistances, general requirements for seismic pre-approved nodes, column panel design, weld, joints with stiffeners at the flanges, connections of stiffeners.

Complex built-up members

Definition of built-up members, examples of built-up members in structures, basic characteristics and application examples, shear deformations, global and local response, analysis of mechanical behaviour, equivalent shear deformation according to EC3, analysis and verifications according to EC3, construction arrangements, examples according to EC3.

Structures of alternative materials - Part 1: Stainless steel

Stainless steel, introduction, chemical composition, mechanical behaviour, member production methods, alloy selection, stainless steel corrosion - EN 1993-1-4 general requirements, mechanical properties, connections - alloys, construction analysis, section classification, ULS – cross-section verifications, ULS - member verifications, SLS, connections - arrangements, Annex A - material selection and durability, Annex B - continuous strength method, numerical example.

Structures of alternative materials - Part 2: Structural aluminium

Introduction, extraction, production, basic properties, alloys, manufacturing methods, welding, structure of EN 1999, application examples, EN 1999-1-1: general structural rules, section classification, section adequacy checks, comparison of section checks with steel, member stability checks, connections, appendices A, B, C, D, F, summary of other provisions EN 1999-1-1, numerical examples.

4. TEACHING METHODS – STUDENT ASSESSMENT

TEACHING METHODS: <i>Πρόσωπο με πρόσωπο, Εξαποστάσεως εκπαίδευση κ.λπ.</i>	The course is delivered face-to-face, with a continuous flow of theory and applications, using projected PowerPoint slides as well as using a traditional chalkboard.	
TEACHING MEDIA: <i>Χρήση Τ.Π.Ε. στη Διδασκαλία, στην Εργαστηριακή Εκπαίδευση, στην Επικοινωνία με τους φοιτητές</i>	Students simulate the structure using a Finite Element Analysis program of their choice, wherever deemed necessary. Excel or MATLAB can be applied, if desired, for solving analytical equations during member and cross-section verification checks. The 3D software Tekla is used for the construction design. Course support and communication with students take place through the electronic platform https://helios.ntua.gr/	
COURSE ARRANGEMENT: <i>Περιγράφονται αναλυτικά ο τρόπος και μέθοδοι διδασκαλίας.</i>	ACTIVITY	IMPORTANCE
<i>Διαλέξεις, Σεμινάρια, Εργαστηριακή Άσκηση, Άσκηση Πεδίου, Μελέτη & ανάλυση βιβλιογραφίας, Φροντιστήριο, Πρακτική (Τοποθέτηση), Κλινική Άσκηση, Καλλιτεχνικό Εργαστήριο, Διαδραστική διδασκαλία, Εκπαιδευτικές επισκέψεις, Εκπόνηση μελέτης (project), Συγγραφή εργασίας / εργασιών, Καλλιτεχνική δημιουργία, κ.λπ.</i>	Lectures and applications Term-project in small groups Home study	39 40 41
<i>Αναγράφονται οι ώρες μελέτης του φοιτητή για κάθε μαθησιακή δραστηριότητα καθώς και οι ώρες μη καθοδηγούμενης μελέτης ώστε ο συνολικός φόρτος εργασίας σε επίπεδο εξαμήνου να αντιστοιχεί στα standards του ECTS</i>	OVERALL:	120

STUDENT ASSESSMENT: <i>Περιγραφή της διαδικασίας αξιολόγησης</i> <i>Γλώσσα Αξιολόγησης, Μέθοδοι αξιολόγησης, Διαμορφωτική ή Συμπερασματική, Δοκιμασία Πολλαπλής Επιλογής, Ερωτήσεις Σύντομης Απάντησης, Ερωτήσεις Ανάπτυξης Δοκιμίων, Επίλυση Προβλημάτων, Γραπτή Εργασία, Έκθεση / Αναφορά, Προφορική Εξέταση, Δημόσια Παρουσίαση, Εργαστηριακή Εργασία, Κλινική Εξέταση Ασθενούς, Καλλιτεχνική Ερμηνεία, Άλλη / Άλλες</i> <i>Αναφέρονται ρητά προσδιορισμένα κριτήρια αξιολόγησης και εάν και που είναι προσβάσιμα από τους φοιτητές.</i>	I. Semester Project (50%) executed by teams of 2 to 3 students, comprising: - Simulation of a steel or aluminium structure using FEA software, selection of an appropriate analysis method according to EC3 or EC9 (M0-M5 or EM), simulation of imperfections and second-order effects, execution of member and cross-section verification checks required by the proposed analysis method, as well as application of a further, inferior, analysis method for obtaining comparative results, geometric configuration of connections. - Design of the construction in a 3D design software, the use of which is taught within the course. II. Written Final Exam (50%) which includes: - Questions based on the theory of the course requiring critical engineering thinking. - Solving numerical exercises related to the lecture contents.
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5. TEXTBOOKS – BIBLIOGRAPHY

- Suggested Bibliography: G.J. Gantes, "Nonlinear Behavior of Structures - Emphasis on Steel Structures", Greek Academic Electronic Books and Aids, 2016. I. Vayas, J. Ermopoulos and G. Ioannidis. "Design of Steel Structures to Eurocodes", 2018. - Related scientific journals: Journal of Constructional Steel Research, International Journal of Steel Structures, International Journal of Non-Linear Mechanics, Engineering Structures, Structures, Thin-Walled Structures, A.S.C.E. Journal of Structural Engineering, A.S.C.E. Journal of Engineering Mechanics, Structural Engineering and Mechanics, Structure and Infrastructure Engineering, Structural Engineering International, International Journal of Space Structures, Journal of the International Association for Shell and Spatial Structures, Computers & Structures.
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