UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

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220224 - Structures of New Generation Materials

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 737 - RMEE - Department of Strength of Materials and Structural Engineering
Academic year: 2018
Degree: MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Teaching unit Optional)
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Teaching unit Optional)
MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Teaching unit Optional)
ECTS credits: 3 Teaching languages: English

Teaching staff

Coordinator: Weyler Perez, Rafael

Others: Hernandez Rojas, Suilio Eliud

Teaching methodology

The course is divided into two parts:
Theoretical sessions in which the instructor introduces the theoretical basis of the concepts, methods and results and illustrates them with examples appropriate to facilitate their understanding, and problem-based learning sessions. The instructor will provide the syllabus and monitoring of activities (ATENEA).

Learning objectives of the subject

This course aims to:
Provide an understanding of the underlying principles and techniques associated with the stress analysis and strength predictions of advanced structures.
Provide a hands-on experience of the solution methods and procedures pertaining to the analysis of real structural problems.

Study load

Total learning time: 75h	Hours large group:	27h	36.00%
	Self study:	48h	64.00%

Content

Module 1: Introduction	Learning time: 3h Theory classes: 2h Self study : 1h

Description:
Definitions and terminology; Types and classification; Constituent materials; Overview of advantages and limitations; General properties; Design requirements; Significance and objectives; The role of stress analysis; Scales of analysis and methods; Engineering applications; Study areas; Current status and future prospects; Suggested readings.

Related activities:
Theoretical and practical sessions.

Module 2: Micromechanical analysis	Learning time: 10h Theory classes: 4h Self study : 6h

Description:
Micromechanical approaches (mechanistic, analytics and empirics); Volume and mass fractions; Representative volume element RVE; Serial-parallel rule of mixtures and modified; Evaluation of the composite elastic properties; Ultimate strengths; Micromechanical failures; Damage models; Hygrothermoelastic (HTE) effects.

Related activities:
Theoretical and practical sessions.

Module 3: Mesomechanical analysis	Learning time: 18h Theory classes: 4h Self study : 14h

Description:
Terminology and notation; Compatibility, constitutive and equilibrium equations; Generalized Hook?s Law; Stress-strain relations of elastic materials; Degrees of anisotropy; Engineering constants; Plane stress state and constitutive relations; Constitutive relations of unidirectional ply; Stiffness of on-axis ply; Engineering constants of on-axis ply; Global and local coordinate references; Multiangle transformation matrices; Coupling effects; Mutual influence coefficients; Hygrothermoelastic (HTE) effects; Ply strength; Failure theories; Polynomial criteria; Failure envelopes.

Related activities:
Theoretical and practical sessions.

Module 4: Macromechanical analysis	Learning time: 23h Theory classes: 8h Self study : 15h

Description:
Stacking sequence and laminate code; Classical laminated plate theory; Kirchhoff hypothesis; Strain-stress relations; In-plane force and moment resultants; General load-deformation relations; Laminate stiffnesses; ABD matrices; Laminate coupling relationships; Classification of laminates; Effective engineering constants; Design considerations; Normalized matrices; Laminate effective engineering constants; Sandwich laminates.

Related activities:
Theoretical and practical sessions.

Module 5: Full-section analysis	Learning time: 16h Theory classes: 7h Self study : 9h

Description:
Composite beams; Governing equations; Solid beams subjected to axial load and bending; Thin-walled open-section and closed-section beams; Torsion of thin-walled beams; Thin-walled with arbitrary stacking sequence; Transversely loaded thin-walled beams; Stiffened thin-walled beams; Buckling of beams; Free vibration

Related activities:
Theoretical and practical sessions.

Module 6: Experimental methods for characterization ant testing	Learning time: 5h Theory classes: 2h Self study : 3h

Description:
Characterization of constituent materials; Physical characterization of composite materials; Tensile, compressive and shear properties; Interlaminar fracture toughness; Biaxial testing; Impact damage and tolerance; Characterization with stress concentrations; Scaling effects in laminated composites; Standard test; Non Destructive testing; Full-scale tests.

Related activities:
Theoretical and practical sessions.

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Qualification system

Partial exam 25 %
Final Exam 40 %
Task assignments 20 %
Proposed activity 15 %

Bibliography

Basic:

Pérez, M. A. Mechanics of Composite Materials. 2012.

Daniel, I. M.; Ishai, O. Engineering mechanics of composite materials. 2nd ed. New York: Oxford University Press, 2006. ISBN 9780195150971.

Gay, Daniel. Composite materials: design and applications. 3rd ed. Boca Raton, FL: Taylor, 2015. ISBN 9781466584877.

Hyer, M. W. Stress analysis of fiber-reinforced composite materials. Boston, Massachusets: McGraw-Hill, 1998. ISBN 9789339205317.

Jones, Robert M. Mechanics of composite materials. 2nd ed. New York: Taylor & Francis, 1999. ISBN 9781560327127.

Tsai, Stephen W. Strength & life of composites. Stanford: Composites Design Group, Composites Design Group. ISBN 9780981914305.