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.

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.
## Content

### Module 1: Introduction

**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.

**Learning time:** 3h  
Theory classes: 2h  
Self study : 1h

### Module 2: Micromechanical analysis

**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.

**Learning time:** 10h  
Theory classes: 4h  
Self study : 6h

### Module 3: Mesomechanical analysis

**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.

**Learning time:** 18h  
Theory classes: 4h  
Self study : 14h
### Module 4: Macromechanical analysis

**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.

**Learning time:** 23h  
- Theory classes: 8h  
- Self study: 15h

### Module 5: Full-section analysis

**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.

**Learning time:** 16h  
- Theory classes: 7h  
- Self study: 9h

### Module 6: Experimental methods for characterization and testing

**Description:**
Characterization of constituent materials; Physical characterization of composite materials; Tensile, compressive and shear properties; Interlaminar fracture toughness; Blaxial 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.

**Learning time:** 5h  
- Theory classes: 2h  
- Self study: 3h
220224 - Structures of New Generation Materials

Qualification system

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

Bibliography

Basic: