



UNIVERSITY OF CHEMICAL TECHNOLOGY AND METALLURGY

CENTRE OF MATERIALS SCIENCE
Materials Science and Engineering
Department of Physical, Mathematical and Technical Sciences
Applied Mechanics

PROGRAMME

Subject - matter: **COMPOSITES**

Degree: **Master Course**

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Sofia 2007

Subject - matter: **COMPOSITES**

Optional course

Total number of hours: **20**

Lectures: 20 hours and Seminars: 10 hours, ECTS CREDITS: **2**

Teaching form	Semester	hours per week
Lectures :	3	4
Seminars :	3	2
Laboratory :		
Project :		
Assessment methods:	<ul style="list-style-type: none">• Current control: Continuous assessment during exercise sessions, one written examinations of 3h• The mark takes into account the active participation in the courses and seminars.	

I. - ANOTATION

This course is a presentation of industrial materials, composites. We are seeking to establish a link between the teaching of Physics, Chemistry and Mechanics and show how the mastery of microstructures makes it possible to confer on materials the desired mechanical or physical properties.

II. – AIMS

Basic approach showing the main particularities of composite materials. Description of the constituents (matrices, fibres, particles) and of the architectures. Processing methods (processing controls a large part of composite performance). Introduction to the mechanical behaviour of composites and laminates (anisotropy of elastic and ultimate properties).

PRE-REQUISITE:

General knowledge of materials science; fracture mechanics, theory of elasticity, polymers and brittle solids.

PERSONAL WORK REQUIRED: about 15 hours

III. – PROGRAM:

III. 1. Lectures – 20 h

- 1. Introduction. Applications, Definition. Theory of composites :** **1h**
Basic concepts and definitions of composite materials
Classification of composite materials
Control of composite materials
- 2. The constituents : Reinforcements, Matrix materials, Interfaces :** **2h**
Types of Matrix Materials: Thermoset, Thermoplastic, Ceramic, Metal
Reinforcement: Fibers, Particles and Whiskers
Textile performs
Interfaces
- 3. Processing routes of composite materials, including technical and some economic factors:** **3h**
Manufacturing fundamentals. Fabrication methods, properties and applications of:
polymer matrix composites, metal matrix composites, ceramic matrix composites,
carbon/carbon composites
Selection, Product Development, Design for Manufacturing,
Arrangements of Reinforcements in Composites
Cost estimation
- 4. Homogenizations of Composites. Effective Property Analysis. Calculus:** **2h**
Voigt and Reuss Models
Hashin and Shtrikman
Phenomenological Approaches: Halpin-Tsai, Tsai-Pagano etc.
- 5. Mechanical Properties of Composite Materials:** **4h**
Generalized Hooke's Law – Anisotropic Material
Basic Composite Mechanics for Stiffness Prediction.
Model for Composite Deformation. Derivation of Elastic Constants
Off-axis loading of a Lamina. Elastic Properties of a Lamina. Tensile-shear Interactions
A Laminate as a Stack of Lamina. Elastic Properties of Laminates.
Internal Stresses in Laminates
- 6. Damage and Fracture of composite materials:** **5h**
Study of damage, failure modes, hygrothermal and transport properties of composites:
Stress transfer, stiffness and strength properties of short fiber composites, Shear lag theory.
Failure Modes for Long Fibre Composites. Tensile and Shear Failures.
Failure of Laminates. Off-axis loading of a Lamina.
Failure Criteria: The Maximum Stress, Tsai-Hill and Tsai-Wu Criteria.
- 7. Mechanical Behaviour of Composites in macro scale.** **3h**
Mechanical Behaviour of Sandwiches and Stratified Structures
- 8. Applications of Composites:** **1h**
Examples in Processing Equipment, High Temperature Applications etc.

III. 2. Seminars – 10 h

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| 1. Processing of polymers and composites - use of software and simulation : | 2h |
| 2. Examples of design of laminated composites: | 2h |
| 3. Macromechanics of laminates: | 2h |
| 4. Durability of Composites Materials: | 2h |
| 5. FEM analysis : | 2h |

IV. - BIBLIOGRAPHY

- [1] **M. REYNE**, « Technologies des composites », Hermes, Paris (1990)
- [2] **B.T. ASTROM**, « Manufacturing of polymer composites », Chapman & Hall, London (1997)
- [3] **S.W. TSAI and H.T HAHN**. « Introduction to composite materials », Technomic Pub. (1980)
- [4] **D. GAY**, « Matériaux Composites », Hermes, Paris (1991)
- [5] **BERTHOLOT J.M.**, Matériaux composites. Masson, Paris, 1996.
- [6] **D. HULL**, An introduction to composites materials, Cambridge University Press (1981)
- [7] **Tsu-Wei CHOU**, Microstructural design of fiber composites, Cambridge Univ. Press (1992)

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