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 : **MECHANICS OF MATERIALS**

Degree: **Master Course**

Presented by:
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Professor Sc.D. Angel BALTOV, Inst of Mechanics, BAS
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Subject - matter : **MECHANICS OF MATERIALS**
Compulsory course
Total number of hours : **60**
Lectures : 40 hours and Seminars : 16 hours, Laboratory : 4 h , ECTS CREDITS : **4**

Teaching form	**Semestre**	**hours per week**
Lectures :	1 st	4
Seminars :	1 st	2
Laboratory :	1 st	2
Assessment methods:	• Lecture examination • One written examination (problems) : 2 h • The mark takes into account the active participation in the courses and seminars.	

I. - ANOTATION

This course is a presentation of different classes of industrial and composite materials. 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.

The “Mechanics of materials” will concern mechanical properties therefore (thermo-elastic behaviour, viscosity, plasticity, brittle failure, ductile failure) of different classes of materials. The accent will be put on relations between the structure of the materials and its mechanical properties.

This relation is often the result of a change of scale between the behaviour of the constitutive elements of the microstructure ("micro" scale) and mechanical behaviour in the macroscopic scale ("macro” scale), we shall undertake therefore in general changes of scale.

The elastic behaviours of the isotropic materials taught in the Technical Universities concern a relatively limited part of the comportment of the solids. The development of the modern technologies involves the creation of new materials with prognoses mechanical behaviours. Due to their heterogeneous structure the industrial materials posses different physical behaviours.

The “Mechanics of materials” aims to teach the plastic and viscous effects in solid materials and to examine their behavior in the case of anisotropy and heterogeneity. These materials are used in the modern industry. One discusses their homogenisation – obtain a fictive homogeneous solid with the same behaviours. One examines the behaviour of composite multilayered plates.

Another important point is the durability of materials in static and cyclic loading conditions. Static and dynamic damages are analysed in the case of environmentally induced creep. One examines coupled problems due to thermal and diffusion attack. One discusses problems concerning the identification of the components of the thermo-conductive tensors on the basis of the inclusion distribution and structure.

II. – AIMS

Basic knowledge of mechanical behaviour of materials. Relation between microstructure and mechanical properties. Introduction to fracture fatigue and creep.To show the physical mechanisms of deformation relating to the laws of behavior as established in the codes of finite elements.

PRE-REQUISITE: General knowledge of materials science; general background in mechanics and in physics of defects; basic notions in strength of materials (elasticity): stresses, strains and elasticity tensors, Hooke law.

PERSONAL WORK REQUIRED : about 20 hours

III. – PROGRAM :

III. 1. Lectures – 40 h

Introduction: 4 h
Mechanics and Materials – Scales, observation and testing – Constitutive equations – Heterogeneity and anisotropy.

Elasticity: 6 h
Cohesive energy, crystalline elasticity, rubber elasticity, symmetries, variational approaches and methods user for numerical calculations.

Elastoplasticity: 6 h
Dislocations, yield stress, grain boundaries, precipitates, plasticity criteria, strain hardening and flow rules, energy methods and limit analysis.

Viscoplasticity and viscoelasticity: 8 h
Polymer chains, thermal activation, void diffusion, creep, linear viscoelasticity, viscoplastic potentials and variational formulation.

Damage, fracture and fatigue: 9 h
Damage mechanisms, cleavage, ductile fracture, continuum damage, linear fracture mechanics, confined plasticity zones, stable and unstable propagation, local criteria, initiation and propagation in fatigue.

Behaviour of heterogeneous media: 6 h
Statistical approaches, inclusion models, precipitates, fibres, composites, homogenization.

III. 2. Seminars – 16h

Elastic anisotropy
1. Hooke's law. Tensor and matrix writing: the tensor description of properties, applied to elasticity **2h**
2. Identification of the material matrix components: **1h**

Heterogeneity
3. Homogenisation. Voigt and Reuss models: **2h**
4. Homogenization. Results concerning long fibre and short fibre composites: **2h**

Viscoelasticity and elastoplasticity
6. Rheological models. Viscoelasticity models: **2h**
7. The Boltzmann theory: **2h**
8. Elastoplasticity models: **1h**

Damage and fracture
9. Dammage developpment in materials: **2h**
10. Fracture of materials. Stress intensity factor: **2h**

III. 3. Laboratories : 4h.

Laboratory experiments on mechanical properties and behavior of homogeneous and composite engineering materials subjected to static, creep, and fatigue loads; behavior of cracked bodies; microstructure-property relationships, and determination of materials properties for use in engineering design:
1. Mechanical properties of materials **(2h)**
2. Verification of basic results of strength of materials **(2h)**

IV. - BIBLIOGRAPHY

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11. Popova M., A. Baltov, Mécanique des matériaux. Sofia, 1998.
12. Sidoroff F., Cours de mécanique, part.1, 2, 3, Lyon, 1984.
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