Course: Surface engineering		
Language: English		
Lecturer: Prof. Sanja Lučić Blagojević; Prof. Mirela Leskovac		
TEACHING	**WEEKLY**	**SEMESTER**
Lectures	**2**	**30**
Laboratory	**2**	**30**
Seminar	**1**	**15**
		Overall:75
		ECTS: 7

PURPOSE:

Gaining knowledge about the surface phenomena, where by surface engineering structure and properties of materials can be modified in general. The basic approach for the development of materials is controlled change of the interfacial properties from nano-level to the micro-and macro-levels. Understanding of tribology provides the necessary knowledge about the mechanisms of friction and wear of materials.

THE CONTENTS OF THE COURSE:

L – lecture; LE – laboratory exercise; S-seminar

L (1-2): Surface phenomena. The processes at surfaces. Surface tension and surface energy. Terminology. Interfacial energy. Wetting and spreading. The surface energy and work of adhesion. Young's equation and the work of adhesion. The characteristics of the surface and the contact angle. Characterization of surfaces.
L (3-4): Adhesion. Definition and theory. The science of adhesion. Basic and practical adhesion. Theories of adhesion: mechanical, adsorption, chemical, electrostatic, diffusion, other theories. Adhesion at interfaces in complex systems in use.
S (1)
LE: LE - Surface tension; LE - Surface phenomena in composites - contact angle; LE - Surface phenomena in composites - gas chromatography; LE - Determination of adhesion parameters
1st partial exam

L (5-6): Polymer surface. Thermodynamics of polymer surfaces. Surface modification of polymers. The reasons for the modification. Pretreatment of the polymer surface. Methods of pretreatment: mechanical, chemical, oxidation, plasma. Identification of the surface. UHV surface analysis. Characterization of polymer surfaces. Characterization methods: AES, XPS, SIMS, EPMA, ATR and others.
L (7-8): Polymer-polymer interface. Examples. Thermodynamics of polymer interphase. Compatibility of the polymer. Symmetrical polymer interface. Self-adhesion. Asymmetrical polymer interface. The thickness and strength of the interface. The diluted polymer solution / solid. The conformation of the polymer chains at the interface.
L (9): Interface in polymer blends. Miscible and immiscible polymers. Interphase in the blends.

L (10): Interface in polymer composites. The impact on the adhesion of the morphology, mechanisms of failure, and mechanical properties. Influence of interfacial properties: microcomposites vs. nanocomposites. The types of polymer nanocomposites. Modification of interface in nanocomposites. New advanced materials.
S (2)
LE: LE - Pretreatment of surfaces; LE - Morphology of the composite system; LE - Failure in composites; LE - Mechanical properties of composites; LE- Interaction coefficients in composites
L (11-12) Adhesive compounds. Types of adhesives. Modification of interface in adhesive joints. The influence of the environment and aging. Testing of adhesive joints.
LE: LE – Testing of adhesive joint.
2nd partial exam

L (14-15): Tribology. Principles and industrial importance of tribology. Micro-and nano-tribology. Structure and properties of solids, characterization of the contact surface and adhesion as a function of the tribological behavior. Friction. The laws of friction in sliding and rolling surfaces. Wearing. The basic mechanisms of wear: adhesion, abrasion, fatigue, tribocorrosion. Wearing of materials: metals and alloys, ceramics, polymers, plastics. Surface treatment. The criterion for selecting lubricants and surface treatment techniques in the industry. The specificity of polymer surfaces and new techniques for measuring tribological properties.
S (3)
LE : LE - Tribological properties of materials - friction; LE - Tribological properties of materials - wear
3rd partial exam

GENERAL AND SPECIFIC COMPETENCE:

General competencies of students are extended with knowledge about phenomena of surface and interface, as well as the possibilities of engineering changes which alter the structure and properties of surfaces and materials as a whole - as an innovative way to new materials.
Specific competencies are related to exploring and modifying of the processes that occur on surfaces in industrial applications such as adhesion, friction, wear, etc.., which are crucial in the adhesion of connecting elements, processing, tribology and surface protection materials.

KNOWLEDGE TESTING AND EVALUATION:

Partial exams, written exam

MONITORING OF THE COURSE QUALITY AND SUCCESSFULNESS:

Student questionnaire.

LITERATURE:

1. V. Kovačević, S. Lučić Blagojević, M. Leskovac, Inženjerstvo površina, interna skripta, 2008.
2. K.L. Mittal, Polymer Surface Modification; Relevance to Adhesion, VSP, Netherland, Vol.2, 2000.
3. Y.S. Lipatov, Adhesion of Polymers at the Interface with Solids, in Polymer Reinforcement, ChemTec Publishing, Toronto, 1995.
4. V. Ivušić, Tribologija, Hrvatsko društvo za materijale i tribologiju, Zagreb, 1998.
5. B. Bhushan, Principles and Applications of Tribology, John Wiley & Sons, New York, 1999.
6. L.H. Sperling, Introduction to Physical Polymer Science, Wiley Interscience, New Yersey, 2006.