UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2021/2022
BACHELOR'S DEGREE (BSC)	BIOMEDICAL ENGINEERING
SUBJECT	PHYSICAL CHEMISTRY FOR BIOMEDICAL ENGINEERING
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50297-Ingegneria chimica
CODE	21190
SCIENTIFIC SECTOR(S)	ING-IND/23
HEAD PROFESSOR(S)	ZAFFORA ANDREA Ricercatore a tempo determinato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**ZAFFORA ANDREA** Monday 13:00 14:00 Tutti i giorni, Studio personale, Edificio 6, Secondo Piano, Stanza 2013. Da concordare tramite e-mail a andrea.zaffora@unipa.it

DOCENTE: Prof. ANDREA ZAFFORA

PREREQUISITES	General chemistry and thermodynamics.
LEARNING OUTCOMES	Knowledge and understanding At the end of the course student is expected to have a deep understanding of the fundamental aspects of Thermodynamics of interfaces and surfaces forces; solid-liquid interfaces, liquid-liquid interfaces, colloid and gel. These fundamental knowledge will be applied to the following technological fields: Drug Delivery and Surface functionalization (super-hydrophobic, antimicrobial). Applying knowledge and understanding Student will be able to: - derive thermodynamic data about Thermodynamics of interfaces; - describe physico-chemical equilibria of solid-liquid interfaces, liquid-liquid interfaces; - design solution for problems about Drug Delivery and Surface functionalization (super-hydrophobic, antimicrobial). Making judgments Staring from knowledge of the theoretical aspects the student is expected to select the suitable solution for the problems about Drug Delivery and Surface functionalization (super-hydrophobic, antimicrobial). Communication Student is expected to be able to discuss about fundamental aspects of Physical chemistry of surfaces and dispersed systems and its biomedical applications. Learning skills Following a deep understanding of the theoretical aspects, student is expected to be able manage technical issues taking advantage of technical manuals, scientific literature updating frequently his/her knowledge.
ASSESSMENT METHODS	The assessment will be performed through an oral exam with questions focused on three main subjects: - Thermodynamics of interfaces, surfaces forces and thermodynamic and kinetic aspects of electrochemical processes; - solid-liquid interfaces, liquid-liquid interfaces, colloid and gel; - biomedical applications of Physical chemistry of surfaces and dispersed systems. The student must support the answers qualitatively and quantitatively taking advantage of the technical tools provided by the evaluation committee (Handbook of thermodynamic constants and kinetic parameters, etc.). The student will also discuss a case study of practical relevance. The interview is aimed at determining the student abilities to process the knowledge gained by using them to solve problems and the ability to express the teaching content using a technically correct language. More specifically, the student must show how he/she is able to use the knowledge of Thermodynamics of interfaces and surfaces forces, thermodynamic and kinetic aspects of electrochemical processes, solid-liquid interfaces, liquid-liquid interfaces, colloid and gel, biomedical applications of Physical chemistry of surfaces and dispersed systems. The vote is expressed in thirtieths with possible praise. A maximum of 24/30 will be attributed according to the student reply on the proposed questions, while the remaining 6/30 and praise will be attributed according to the discussion on the case study. In order to get the minimum score for a positive evaluation (18/30), the student must know the general aspects of the course content (Thermodynamics of interfaces and surfaces forces, thermodynamic and kinetic aspects of electrochemical processes, solid-liquid interfaces, liquid-liquid interfaces, colloid and gel). His/her command of technical language must be sufficient to clearly discuss with the evaluation committee about the main aspects of the course. Higher score will be attributed according to their ability in applying knowledge and skills learned in this course to practical and technical problems, according to what extent students are aware of the steps they go through in solving problems and how well can they explain their problem-solving steps.
EDUCATIONAL OBJECTIVES	At the end of the course student is expected to have a deep understanding of the fundamental aspects of Thermodynamics of interfaces and surfaces forces; solid-liquid interfaces, liquid-liquid interfaces, colloid and gel. These fundamental knowledge will be applied to the following technological fields: Drug Delivery and Surface functionalization (super-hydrophobic, antimicrobial).
TEACHING METHODS	Frontal lectures and exercise.
SUGGESTED BIBLIOGRAPHY	H.J. Butt, K. Graf, M. Kappl, Physics and Chemistry of Interfaces, Wiley-VCH ISBN: 978-3-527-60640-5; J.C. Berg, An Introduction to Interfaces and Colloids: The Bridge to Nanoscience, World Scientific ISBN: 978-981-4293-07-5; P.C. Hiemenz, R. Rajagopalan, Principles of Colloid and Surface Chemistry, CRC Press ISBN 9780824793975. G. Bianchi- T. Mussini, Fondamenti di Elettrochimica, Masson (1993)

SYLLABUS

Hrs	Frontal teaching
14	Course brief introduction. Galvanic cells energetics. Electrolytic solutions. Aqueous and non aqueous solutions. Fundamentals of electrochemical processes kinetics: charge transfer and mass transfer kinetic control. Faradaic and not faradaic processes (interfaces). Electrode/electrolyte double layer. Helmholtz, Gouy-Chapman and Stern-Grahame models
12	Thermodynamics of interfaces, Surface and interfacial tension, Young-Laplace equation, capillary rise, contact angle, surface tension and stress in solids, Kelvin equation and capillary condensation, dynamic effects on surface tension and contact angle, Gibbs Equation, Wettability measurements. Surface forces. Measurement of surface forces.
4	Thermodynamics of adsorption, Adsorption models, The Langmuir adsorption isotherm, The BET adsorption isotherm, Experimental aspects of adsorption from the gas phase
6	The electrostatic double-layer force, The DLVO theory, Zeta Potential, Electrokinetic phenomena.
4	Surfactants, Thermodynamics of micellization, The critical micelle concentration, Macroemulsions, Microemulsions, Foams
4	Definition of colloids. Classification of colloids. Sol/gel. Experimental characterization of colloids. Rheological properties of colloidal dispersions. Colloids preparation methods.
14	Fundamentals of electrochemical energy storage and conversion systems. Systems for wearable technologies for Biomedical Engineering. Batteries for wearable devices. Corrosion processes: Pourbaix diagrams, corrosion forms and rate, corrosion protection. Electrochemical sensors for Biomedical Engineering.
8	Biomedical Applications. The Use of Nanoparticles for Drug Delivery and Targeting (nanoparticles, liposomes, hydrogels, microemuslions). Chemical and Physical Methods to Synthesize NPs: emulsion free radical polymerization, emulsion-evaporation, and nanoprecipitation. Ionotropic gelation processes. Surface functionalization (super-hydrophobic, antimicrobial). Case studies on applications for Biomedical Engineering.

Hrs	Practice
6	Thermodynamics of galvanic cells. Numerical exercises on galvanic cells kinetics. Tafel slope and exchange current density estimate. Charge transfer resistance and limiting current density estimate.
3	Thermodynamics of interfaces, Surface and interfacial tension, Young-Laplace equation, capillary rise, contact angle, surface tension and stress in solids, Kelvin equation and capillary condensation, dynamic effects on surface tension and contact angle, Gibbs Equation, Wettability measurements. Surface forces. Measurement of surface forces.
3	Surfactants, Thermodynamics of micellization, The critical micelle concentration, Macroemulsions, Microemulsions, Foams.Definition of colloids. Classification of colloids. Sol/gel. Experimental characterization of colloids. Rheological properties of colloidal dispersions. Colloids preparation methods.
3	Biomedical Applications. The Use of Nanoparticles for Drug Delivery and Targeting (nanoparticles, liposomes, hydrogels, microemuslions). Chemical and Physical Methods to Synthesize NPs: emulsion free radical polymerization, emulsion-evaporation, and nanoprecipitation. Ionotropic gelation processes. Surface functionalization (super-hydrophobic, antimicrobial).