



UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2019/2020
BACHELOR'S DEGREE (BSC)	ELECTRICAL ENGINEERING FOR THE E-MOBILITY
INTEGRATED COURSE	CHEMISTRY AND ELECTROCHEMICAL ACCUMULATION SYSTEMS - INTEGRATED COURSE
CODE	20443
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	ING-IND/23, CHIM/07
HEAD PROFESSOR(S)	
OTHER PROFESSOR(S)	DI FRANCO Professore Associato Univ. di PALERMO FRANCESCO BELLARDITA MARIANNA Professore Associato Univ. di PALERMO
CREDITS	12
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	BELLARDITA MARIANNA Monday 10:00 12:00 Tutti i giorni, previo appuntamento da concordare via mail: marianna.belardita@unipa.it Per il momento i ricevimenti si svolgeranno on-line DI FRANCO FRANCESCO Monday 13:00 14:00 Studio personale. Wednesday 13:00 14:00 Studio personale. Friday 13:00 14:00 Studio personale.

DOCENTE:

PREREQUISITES	
LEARNING OUTCOMES	
ASSESSMENT METHODS	
TEACHING METHODS	

MODULE ELECTRO-CHEMICAL ACCUMULATION SYSTEMS

Prof. FRANCESCO DI FRANCO

SUGGESTED BIBLIOGRAPHY

Verranno segnalati recenti articoli scientifici sugli argomenti trattati e fornite delle dispense.
Modern Batteries - An Introduction Electrochemical to Power Sources, C A Vincent, B Scrosati, Butterworth-Heinemann, Oxford, 1997

AMBIT	10657-Attività formative affini o integrative
INDIVIDUAL STUDY (Hrs)	51
COURSE ACTIVITY (Hrs)	24

EDUCATIONAL OBJECTIVES OF THE MODULE

The first part of the course is aimed to provide the basic (theoretical and technological) concepts on electrochemical energy conversion. The second part will be devoted to the description of the devices (Batteries, fuel cells, supercapacitors) correlating the device electric performance to the materials used to realize the device and to the electrochemical processes occurring inside the device.

SYLLABUS

Hrs	Frontal teaching
6	Brief introduction. Basic electricity with an emphasis on Ohm's Laws. Classification of energy conversion devices. Schematic representation of a galvanic cell. Thermodynamics of galvanic cells. Electrolytic solution: conductivity and thermodynamic stability window. Aqueous and non aqueous solutions.
4	Kinetic aspects of electrodic reaction: overvoltage. Charge transfer and mass transfer at the electrode electrolyte interface. Polarization curves.
2	Faradaic and not Faradaic interfaces. Electrode/electrolyte interface.
4	Electrochemical energy conversion and storage: advantages and disadvantages. Application of battery, fuel cell and capacitors. Figure of Merit.
2	Primary conventional battery: Leclanche' cells. Primary conventional battery: Zn alkaline, Zn-HgO, Cd-HgO. Primary conventional battery: Zn-Ag ₂ O, Zn-air. Primary lithium cell: advantages and disadvantages of lithium anode. Primary lithium cell: solid cathode Primary lithium cell: liquid cathode. Primary lithium cell: solid electrolyte. Reserve Batteries.
5	Secondary cells: discharge reaction mechanisms. Lead - acid battery. Secondary cells: Ni-Cd, Ag-Zn. Secondary advanced cells: Zn- alkaline, Ni-H ₂ , Ni.MH. Secondary advanced cells: Zn-air, Al-air, ZEBRA. Secondary advanced cells: lithium metal batteries. Secondary advanced cells: lithium ion batteries. Carbon based intercalation negative electrodes. Secondary advanced cells: lithium ion batteries. Co, Ni and Mn oxides positive electrodes. Polymer-based practical cells: 1) Lithium polymer batteries and 2) plastic lithium ion batteries.
2	Electrochemical capacitors. EDLC. Pseudo-supercapacitors. Elements on Fuel cells.
2	General overview of the electrochemical energy conversion and storage devices. Ragone plot. Examples of electrochemical storage devices in automotive industries.

MODULE CHEMISTRY

Prof.ssa MARIANNA BELLARDITA

SUGGESTED BIBLIOGRAPHY

M. Schiavello e L. Palmisano "Fondamenti di Chimica" V Ed. Edises.
D. W. Oxtoby, H. P. Gillis, L. J. Butler "Chimica Moderna" V Ed. Edises (in alternativa al primo).
F. Cacace, M. Schiavello "Stechiometria" Ed. Bulzoni (facoltativo).
P. Giannoccaro - S. Doronzo "Elementi di Stechiometria" II Ed. Edises (facoltativo).

AMBIT	50293-Fisica e chimica
INDIVIDUAL STUDY (Hrs)	153
COURSE ACTIVITY (Hrs)	72

EDUCATIONAL OBJECTIVES OF THE MODULE

At the end of the course the student will be able to understand how the knowledge of some basic concepts of General Chemistry is the basis of almost all technologies and how they can be used in the performance of their profession. For the graduate in Electrical Engineering the basic concepts of Chemistry are fundamental for understanding the behavior of the materials. However, the main goal is to provide the students with awareness of the vital role that the discipline has in the production of all types of materials used in the engineering field.

SYLLABUS

Hrs	Frontal teaching
3	Introduction to the course. Fundamental laws of chemistry
2	Atomic theory
2	Periodic table of the elements
2	Inorganic compounds nomenclature
2	The chemical bond
1	The gaseous state
1	The liquid state
2	The solid state
2	Elements of thermodynamics
1	Chemical kinetics
1	Phase diagrams for one-component systems
2	Two-component systems
2	Colligative properties
3	Chemical equilibrium
3	Ionic equilibria
2	Buffer solutions. Titration curves
3	Nucleus stability and instability. Radioactivity.
3	Electrochemistry
2	The gaseous state
3	Ionic equilibria
Hrs	Practice
1	Atomic theory of the matter. Fundamental laws of chemistry
2	The mole. Empirical and molecular formulas. Equivalent weight
2	Stoichiometry. Limiting reactant
2	The chemical bond. The hybrid orbitals
2	Red-ox reactions
2	Inorganic nomenclature. Structure formulas
1	Thermodynamic's elements
3	Two-component systems. Colligative properties
3	Chemical equilibrium
3	Buffer solutions. Titration curves
2	Solubility product
2	Electrochemistry
3	Background of organic chemistry: nomenclature
2	Resolution of exam tests