

**Syllabus of Professional
Master's Degree in Physico-
Chemical Analysis and
Environment APCE
Curriculum**

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Module Title	Molecular Spectroscopy																																
Semester(s) in which the module is taught	First Semester																																
Person responsible for the module	Dr. Abir HALOUI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, directed work, practical work .																																
Workload (including contact hours, selfstudy hours)	Total workload: 49h Contact hours 49h : Course: 21h , DW: 14h ; PW: 14h , Private study, including exam preparation: 49h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	Fundamental chemistry and physics, Applied mathematics, spectroscopy concenpts, Practical skills.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td></td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X				X					
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X				X																												
Content	This teaching unit enables students to perfect their knowledge in the field of structural chemistry. Initially, students will receive theoretical training in the main spectroscopic techniques (UV/visible, infrared, proton and 13C NMR, absorption and atomic emission), enabling them to understand the principle and usefulness of each technique. They will also learn how these techniques complement each other in elucidating the structure of chemical structures in solution, in solids and on surfaces.																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	Molecular Spectroscopy" (2nd Edition) – Jeanne L. McHale Fundamentals of Molecular Spectroscopy" – Prabal Kumar Mallick Atomic and Molecular Spectroscopy" (5th Edition) – Sune Svanberg																																

Module Title	Atomic Spectroscopy											
Semester(s) in which the module is taught	First Semester											
Person responsible for the module	Dr. Nouioui											
Language	French											
Relation to the curriculum	<i>Mandatory</i>											
Teaching methods	<i>Lessons, Practical work, Personal practical work.</i>											
Workload (including contact hours, self-study hours)	<i>Total workload : 42h</i> <i>Contact hours 35 h : Course: 21h , PW: 14h , PPW: 7h , Private study, including exam preparation: 42h</i>											
Credit points	3											
Required and recommended prerequisites for participating in the module	<i>Fundamental chemistry and physics, Applied mathematics, Data analysis, spectroscopy concepts, Practical skills.</i>											
Module objectives/intended learning outcomes												
	<i>SLO 1</i>	<i>SLO 2</i>	<i>SLO3</i>	<i>SLO4</i>	<i>SLO5</i>	<i>SLO6</i>	<i>SLO7</i>	<i>SLO8</i>	<i>SLO9</i>	<i>SLO10</i>	<i>SLO11</i>	
	X	X	X			X						
Content	<i>Atomic spectroscopy</i> <i>Atomic absorption and emission spectroscopy</i> - Chapter I: Atomic absorption spectrometry with flame. - Chapter II: Disturbances of atomic absorption spectrometry. - Chapter III: Electrothermal atomic absorption spectrometry. - Chapter IV: Analysis of the elements by the hydride generation method coupled with atomic absorption spectrometry and analysis of mercury by spectrometry <i>atomic absorption in cold vapor.</i> - Chapter V: Flame atomic emission spectrometry. - Chapter VI: Plasma atomic emission spectrometry. - Applications: ISO international standards											
Exam forms	<i>Writing exam</i>											
Study and examination conditions	<i>The student must have an overall average of at least 10/20</i>											
Reading list	Atomic Spectra and Atomic Structure" (G. Herzberg) – Classic reference "Modern Spectroscopy" (J.M. Hollas) – Instrumentation focus "Fundamentals of Atomic and Molecular Physics" (R. Brooks) – Theory + problems											

Module Title	Analytical Chemistry											
Semester(s) in which the module is taught	First Semester											
Person responsible for the module	Dr. Mohamed Younes KADRI											
Language	French											
Relation to the curriculum	Mandatory											
Teaching methods	lectures, Direct work, practical work, Personal practical work.											
Workload (including contact hours, selfstudy hours)	Total workload: 84 h Contact hours 63 h : Course: 21 h , DW: 21h ; PW: 21h , PPW: 21h , Private study, including exam preparation: 84h											
Credit points	6											
Required and recommended prerequisites for participating in the module	■ A solid foundation in general chemistry is essential. This includes understanding basic chemical principles, stoichiometry, and reactions. ■ Basic laboratory techniques, including pipetting, titration, and use of standard laboratory equipment (e.g., balances, spectrophotometers), are often required.											
Module objectives/intended learning outcomes	SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	
	X	X	X		X	X	X	X				
Content	Chapter 1: Introduction, Analytical Chemistry Units, Errors in chemical analysis, Application of statistics to data processing and evaluation Chapter 2: Sampling in analytical chemistry, Analysis of real samples, Sample preparation, Elimination of interference Chapter 3: Chemistry in aqueous solution, The effect of electrolytes on ionic balances, Application of equilibrium calculations to complex systems (acid-base, complexation, oxidation-reduction, precipitation, apparent constants balances) Chapter 4: Titrimetric methods Preparing solutions, The theory of titration curves (construction, optimal precision, etc.), Different types of titrations (direct, indirect, feedback, etc.) Chapter 5: Acid-base titrations and applications Chapter 6: Precipitation titrations and applications Chapter 7: Complexometric titrations and applications Chapter 8: Oxidation-reduction titrations and applications Chapter 9: Gravimetric methods											
Exam forms	Writing exam											
Study and examination conditions	The student must have an overall average of at least 10/20											
Reading list	Fundamentals Of Analytical Chemistry (Hardcover) by Douglas A. Skoog Analytical Chemistry and Quantitative Analysis – David S. Hage, James R. Carr Quality Assurance in the Analytical Chemistry Laboratory – M. Parkany											

Module Title	Separation and chromatographic analysis											
Semester(s) in which the module is taught	First Semester											
Person responsible for the module	<i>Dr. Lassad Ben Hammouda</i>											
Language	French											
Relation to the curriculum	Mandatory											
Teaching methods	Lessons, Direct Work; Practical work											
Workload (including contact hours, self-study hours)	Total workload: 49h Contact hours 49h : Course: 21h , DW: 14h ; PW: 14h , Private study, including exam preparation: 49h											
Credit points	3											
Required and recommended prerequisites for participating in the module	A solid understanding of general chemistry and basic analytical chemistry.											
Module objectives/intended learning outcomes	SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	
	X	X	X		X	X		X				
Content	Separation and chromatographic analysis - Liquid phase chromatography: Fundamental quantities - The different types of chromatography (exclusion, adsorption, partitioning, reversed phase, ion pair, ionic, chiral) -The equipment and the different types of detectors - Optimization of analysis conditions. - Gas chromatography - Capillary electrophoresis - LC/MS coupling: Principles and areas of application.											
Exam forms	Writing exam											
Study and examination conditions	The student must have an overall average of at least 10/20											
Reading list	"Chromatography: Concepts and Contrasts" – James M. Miller "Introduction to Modern Liquid Chromatography" – Lloyd R. Snyder, Joseph J. Kirkland, John W. Dolan "Principles and Practice of Modern Chromatographic Methods" – Kevin Robards, Paul R. Haddad, Peter E. Jackson											

Module Title	Analysis methods of solids																																
Semester(s) in which the module is taught	First Semester																																
Person responsible for the module	Dr. Lassad Ben Hammouda																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, Directed work, Practical work .																																
Workload (including contact hours, selfstudy hours)	Total workload: 49h Contact hours 49h : Course : 21h , DW: 14h ; PW: 14h , Private study including exam preparation: 49h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A foundational knowledge of solid-state chemistry, general analytical techniques, and basic physics principles.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X		X	X	X					
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X		X	X	X																												
Content	Solids analysis techniques 1- Electron microscopy: determination of the average particle size, the dispersion of metals in a solid, the composition of particles by MET-EDX,... 2- X-ray diffraction on powders: Quantitative analysis of solid materials by the RIR method and other methods like that of adding standards,... Determination of the average particle size by the Debay-Scherrer method,.. Qualitative analysis: determination of the different elements contained in a material solid by the use of databases, different crystalline phases present in a compound, .. 3- Thermal analysis Thermogravimetric analysis, differential thermal analysis, ATG-CPG-MS coupling Applications to pharmaceutical materials 4- Mechanical analysis of composite and polymer materials																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Solid State Chemistry and its Applications" – Anthony R. West "Principles of Instrumental Analysis" – Douglas A. Skoog, F. James Holler, Stanley R. Crouch "Thermal Analysis: Fundamentals and Applications to Material Characterization" – M. E. Brown "Scanning Electron Microscopy and X-Ray Microanalysis" – Joseph Goldstein et al.																																

Module Title	Standards and quality																																
Semester(s) in which the module is taught	First Semester																																
Person responsible for the module	Dr. Hajer MAGHRAOUI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, personal practical work.																																
Workload (including contact hours, selfstudy hours)	Total workload: 32h Contact hours 21h : Course : 21h , PPW:10.5h , Private study including exam preparation: 50h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A basic understanding of analytical chemistry, laboratory practices, and fundamental concepts of quality control.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X		X	X		X	X		X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X		X	X		X	X		X	X																							
Content	Part 1 : Standards Part 2: Analytical Quality Management																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Statistical Methods for Quality Improvement" Thomas P. Ryan "Juran's Quality Handbook: The Complete Guide to Performance Excellence" Joseph A. Defeo (J.M. Juran) "Quality Management Systems: A Practical Guide" Ray Tricker																																

Module Title	Health, safety and quality																																
Semester(s) in which the module is taught	First Semester																																
Person responsible for the module	Dr Wafa ESSAFI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, Personal practical work.																																
Workload (including contact hours, selfstudy hours)	Total workload: 32h Contact hours 21h : Course : 21h , PPW:10.5h , Private study including exam preparation: 50h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A basic understanding of chemistry, biology, and general laboratory practices, as well as foundational knowledge of risk assessment and quality control principles.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X		X	X		X	X		X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X		X	X		X	X		X	X																							
Content	- Industrial risk management policy Analysis. - Prevention. Forecasting. Operational management. Return to normal. - Industrial regulations, Storage and Activities - Potential fire hazard: Fire. Combustion. Extinguishing media. - Hygiene and respect for the environment																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Occupational Health and Safety for the 21st Century" – Robert H. Friis "Fundamentals of Occupational Safety and Health" – Mark A. Friend & James P. Kohn "Laboratory Safety for Chemistry Students" – Robert H. Hill Jr. & David C. Finster																																

Module Title	Chemical engineering																																
Semester(s) in which the module is taught	First Semester																																
Person responsible for the module	Dr. Arbi MGAIDI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, Personal practical work.																																
Workload (including contact hours, selfstudy hours)	Total workload: 32h Contact hours 21h : Course : 21h , PPW:10.5h , Private study including exam preparation: 50h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid foundation in general chemistry, physics, mathematics (especially calculus and differential equations), and thermodynamics.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X		X	X		X	X		X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X		X	X		X	X		X	X																							
Content	Balance sheets: Material and heat, As a tool for modeling, Fluid Mechanics (momentum transfer), Newton's law and Reynolds number, Quantity of Movement Assessment:- Laminar regime- Turbulent regime- Bernoulli relation and Applications-Fixed bed- Fluidized bed, Heat transfer, Fourier's law , Transfer by conduction, convection and radiation, Calculation of a heat exchanger, Material Transfer, Fick's law, Definition of the diffusion coefficient, Local and global mass transfer coefficients																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Elements of Chemical Reaction Engineering" – H. Scott Fogler (5e édition) "Chemical Reactor Analysis and Design" – G.F. Froment, K.B. Bischoff & J. De Wilde "Chemical and Engineering Thermodynamics" – Stanley I. Sandler "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design" – Gavin Towler & Ray Sinnott																																

Module Title	Energy efficiency																																
Semester(s) in which the module is taught	First Semester																																
Person responsible for the module	Dr. Arbi MGAIDI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, Personal practical work.																																
Workload (including contact hours, selfstudy hours)	Total workload: 32h Contact hours 21h : Course : 21h , PPW:10.5h , Private study including exam preparation: 50h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid foundation in general chemistry, physics, mathematics (especially calculus and differential equations), and thermodynamics.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td></td><td></td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X			X		X	X		X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X			X		X	X		X	X																							
Content	I- Introduction to the concept of energy, 1- What is energy?,2- Problems concerning energy, 3- Energy sources, 4- Energy consumption, 5- Energy and power II- Energy sources, 1- Disadvantages of non-renewable energy sources (fossil and nuclear), 2- Renewable energies, 3- Use of renewable energies in industry III- The transformation of energy and its use in industry, 1- Energy conversion (energy vectors), - Types of energy and heat carriers, - Fuel production, - Electricity production, - Combined cycle power plants, - Combined production plants, 2- End uses of energy in industry, - Boiler operation, - Ventilators and resuscitators, - Compressed air, - Refrigerants, - Sources IV- Energy efficiency in the paper industry, 1- The life cycle of paper, 2- Raw materials for paper production, 3- Paper production process, Paper recycling / Use of virgin fibers																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Energy Efficiency: Towards the End of Demand Growth" – Fereidoon P. Sioshans "Handbook of Energy Efficiency in Process Industries" – Barney Capehart & Azadeh Y. Osborn																																

Module Title	Air pollution control																																
Semester(s) in which the module is taught	Second Semester																																
Person responsible for the module	Dr Zouhaier KSIBI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, Directed work.																																
Workload (including contact hours, selfstudy hours)	Total workload: 35h Contact hours 35h : Course: 21h , DW:14h , Private study including exam preparation: 55h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid understanding of environmental chemistry, fluid mechanics, and basic thermodynamics.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td></td><td></td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X			X	X	X			
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X			X	X	X																										
Content	1- General Introduction 2- Methods for quantifying air emissions 3- Techniques for depolluting industrial atmospheric emissions 4- Dusting and demisting 5- Elimination of gaseous emissions 6- Absorption with chemical reaction 7- Adsorption 8- Elimination of nitrogen oxides from combustion gases 9- Flue gas desulfurization 10- VOC treatment processes																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Air Pollution: Its Origin and Control" – Kenneth Wark, Cecil F. Warner & Wayne T. Davis "Air Quality, Fourth Edition" – Thad Godish, Joshua S. Fu "Air Pollution Control Engineering" – Noel de Never																																

Module Title	Environmental management system																																
Semester(s) in which the module is taught	Second Semester																																
Person responsible for the module	Dr Rachid NASRI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons.																																
Workload (including contact hours, selfstudy hours)	Total workload: 21h Contact hours 35h: Course: 21h. Private study including exam preparation: 70h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A foundational understanding of environmental science, sustainability principles, and basic knowledge of environmental regulations and policy.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X	X		X	X	X			
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X	X		X	X	X																										
Content	1- General introduction: institutional framework and environmental legal framework in Tunisia 2- Regulatory cycle 3- Minimum criteria 4- Control, Permit and authorization 5- Law on water discharges: scope, meaning and technological responses 6- Atmospheric Emissions Act: scope, meaning and technological responses 7- Solid Waste Law: scope, meaning and technological responses 8- Environmental management 9- Planning 10- ISO 14 0 standard																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Environmental Management Systems: Understanding Organizational Drivers and Barriers" – Stephen Tinsley & Ilona Pillai "Environmental Management Systems: A Step-by-Step Guide to Implementation and Maintenance" – Christopher Sheldon & Mark Yoxon "Environmental Management for Sustainable Development" – Chris Barrow																																

Module Title	Electrochemical analysis methods																																
Semester(s) in which the module is taught	Second Semester																																
Person responsible for the module	Dr Abdessatar CHERNI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, Direct work, Practical work.																																
Workload (including contact hours, selfstudy hours)	Total workload: 56h Contact hours 56h: Course: 21h .DW: 14h, PW: 21h. Private study including exam preparation: 50h																																
Credit points	6																																
Required and recommended prerequisites for participating in the module	A solid background in physical chemistry, particularly thermodynamics and kinetics, as well as basic knowledge of electrochemistry and analytical chemistry techniques.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X	X	X	X		X			
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X	X	X	X		X																										
Content	1- Definitions of electrochemical processes: <i>Transfer of matter; diffusion migration, convection; Faraday's law; Electrolysis.</i> 2- Morphologies of intensity-potential curves: <i>Rapid electrochemical system; Slow electrochemical system; parameter determinations</i> <i>electrochemical: Diffusion limit current; Residual current: Electroactivity range</i> 3- Study of electrochemical systems: <i>Calculation of simple, successive redox system potential intensity curves.</i> 4- Electroanalytical methods: <i>Potentiometer; Amperometry; Coulometric Methods.</i> 5- Polarography 6- Conductometric methods <i>Content of the supervised work</i> <i>Directed work which focuses on the applications of electrochemistry in the field analysis: dosages of trace elements; Electrolysis cells</i>																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Electrochemical Methods: Fundamentals and Applications" – Allen J. Bard & Larry R. Faulkner "Electroanalytical Chemistry: A Series of Advances" – Edited by Allen J. Bard & Cynthia G. Zoski "Fundamentals of Electroanalytical Chemistry" – Paula Y. Bruice et M. S. V. C. Pillay																																

Module Title	Analysis of air, soil and sediments																																
Semester(s) in which the module is taught	Second Semester																																
Person responsible for the module	Dr Zouhaier KSIBI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, direct work, practical work.																																
Workload (including contact hours, selfstudy hours)	Total workload: 49h Contact hours 49h : Course: 21h .DW: 14h, PW: 14h. Private study including exam preparation: 49h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in environmental chemistry, analytical techniques, and basic knowledge of sampling and instrumentation methods.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X				X				
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X				X																											
Content	Air, soil and sediment analysis, Chemistry and air pollution,Earth's atmosphere,Composition and property,Atmospheric chemistry, Air quality and regulations, Carbon dioxide, Main sources and sinks, Properties and greenhouse effect, Carbon monoxide, Main sources and sinks, Toxicity and health effects, Sulfur compounds, Main sources and sinks, Acid rain and forest dieback, Nitrogen oxides Main sources and sinks, Effects of NO x on organisms, Volatile organic compounds Overview ,Methane, Photooxidants, Exhaust gases, Ozone, Formation and properties, Catalytic destruction, Ozone hole, Chlorofluorinated hydrocarbons, chlorinated hydrocarbons, Aerosols, Sources and properties, Dimensions, lifespan, distribution, HPA, Fumes, Asbestos1, Digestion gas analyzes (anaerobic treatment), Odor analyzes, Chemistry and pollution of soils and sediments, Definitions, Composition, Soil classification, Major constituents, Chemistry at interfaces, Soil acidification, Dissolution, Complexity, Adsorption and pHzpc, Ion exchange, Analyzes of deposits, soils and sediments, Sample preparation, Physico-chemical examinations, Determination of moisture and loss on ignition, Determination of density, Determination of particle size fractions, pH determination, soil pollution Regulation of polluted sites, Pollutants of industrial origin, Pollutants of agricultural origin, Pollutants of atmospheric origin, Sewage sludge.																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Air Sampling and Industrial Hygiene Engineering" – John A. Keith "Soil and Environmental Analysis: Modern Instrumental Techniques" – Keith A. Smith & Malcolm S. Cresser "Environmental Soil Chemistry" – Donald L. Sparks																																

Module Title	Analysis of water and water effluents																																
Semester(s) in which the module is taught	Second Semester																																
Person responsible for the module	Dr Amine MNIF																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, direct work, Practical work.																																
Workload (including contact hours, selfstudy hours)	Total workload: 49h Contact hours 49h : Course: 21h .DW: 14h, PW: 14h. Private study including exam preparation: 49h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in physical chemistry, particularly thermodynamics and kinetics, as well as basic knowledge of electrochemistry and analytical chemistry techniques.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td></td><td></td><td></td><td>X</td><td>X</td><td></td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X				X	X				
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X				X	X																											
Content	Students must acquire comprehensive knowledge and technical skills in the qualitative and quantitative analysis of natural water and wastewater. They should be able to apply standard sampling protocols, carry out proper sample preparation, and utilize advanced analytical techniques such as spectrophotometry, atomic absorption spectroscopy (AAS), inductively coupled plasma (ICP), and chromatography (GC/HPLC) to detect and quantify a wide range of physical, chemical, and biological contaminants. The module also develops their ability to ensure quality control, validate analytical data, and comply with international water quality standards such as those from the WHO, EPA, or EU directives. By the end of the course, students should be capable of designing and conducting water monitoring programs, evaluating treatment processes, and interpreting results in relation to environmental safety and public health.																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	Standard Methods for the Examination of Water and Wastewater" – APHA, AWWA, WEF "Water Quality: Characteristics, Modeling and Modification" – Voudouris, Vasilis "Water and Wastewater Engineering" – Mackenzie L. Davis																																

Module Title	English and communication technics																																
Semester(s) in which the module is taught	Second Semester																																
Person responsible for the module	Leila OUNI and Haithem JARBOUI																																
Language	English																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, direct work																																
Workload (including contact hours, selfstudy hours)	Total workload: 42h Contact hours 42h : DW: 42. Private study including exam preparation: 65h																																
Credit points	4																																
Required and recommended prerequisites for participating in the module	Basic English																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td>X</td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X								X	X	
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X								X	X																								
Content	Students must become familiar with technical terms Develop language skills (style + grammar in context); deploy the techniques necessary for understanding texts and articles scientists ; Strengthen the ability to use more sophisticated grammar like tenses (The Use of Mixed Tenses), the passive voice (The Passive Form), the conditional (Conditional Clauses), prepositions ; know how to communicate in ENGLISH																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"English for Science and Engineering" – Ivor Williams "Cambridge English for Scientists" – Tamzen Armer (Cambridge University Press) "Academic Writing for Graduate Students" – John M. Swales & Christine B. Feak "English for Environmental Science in Higher Education Studies" – Richard Lee (Garnet Education)																																

Module Title	Tutored project																																
Semester(s) in which the module is taught	Second Semester																																
Person responsible for the module	Zouhaier KSIBI, Mohamed Kadri YOUNES, Amine MNIF and Lassad BEN HAMMOUDA																																
Language	Frensh																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, direct work																																
Workload (including contact hours, selfstudy hours)	Total workload: 21h Contact hours 21h : DW: 21. Private study including exam preparation: 40h																																
Credit points	2																																
Required and recommended prerequisites for participating in the module	A solid foundation in their field of study, the ability to work independently, and basic skills in research methodology, critical thinking, and scientific communication.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td></td><td>X</td><td></td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X		X				X	X	X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X		X				X	X	X	X																							
Content	A clear research objective, literature review, methodology, data analysis, results interpretation, and a written report or presentation under the guidance of a supervisor.																																
Exam forms	Oral defense before an academic jury.																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	The reading list for a tutored project typically includes scientific articles, textbooks, courses, technical reports, and relevant standards or guidelines related to the project’s research topic.																																

Module Title	Process engineering																																
Semester(s) in which the module is taught	Second Semester																																
Person responsible for the module	Dr Hanen NAJJAR																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons,																																
Workload (including contact hours, selfstudy hours)	Total workload: 21h Contact hours 21h : Course: 21h . Private study including exam preparation: 70h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	Knowledge of basic physical quantities (pressure, temperature, flow rate, volume, etc.) ; Basic understanding of energy balances and heat transfer; Familiarity with liquid/gas/solid phases and their interactions ; Ability to solve simple algebraic and differential equations; Some basic concepts in chemical engineering																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X	X	X	X	X	X	X	X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X	X	X	X	X	X	X	X	X																							
Content	Chapter 1: Introduction to Separation Processes Chapter 2: Unit Operations for Liquid Effluent Treatment: Sedimentation – Decantation – Filtration Chapter 3: Unit Operations for Solid Waste Treatment: Fragmentation – Screening – Agglomeration – Transport and Storage Chapter 4: Unit Operations for Gas Treatment: Absorption – Dust Removal – Stripping																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	• Koller, E. (2010). Aide-mémoire – Génie chimique (3^e éd.). Paris : Dunod. • Richardson, J. F., Harker, J. H. & Backhurst, J. R., with Coulson, J. M. (2002). Coulson & Richardson's Chemical Engineering, Vol. 2: Particle Technology and Separation Processes (5^e éd.). Oxford–Boston: Butterworth-Heinemann. • Techniques de l’Ingénieur (2012-2017). Opérations unitaires : Génie de la réaction chimique (Réf. Internet ti452). Saint-Denis : Éditions Techniques de l’Ingénieur. Access via catalogue online. • Bostyn, S., Chedeville, O. & Fauduet, H. (2019). Génie chimique et des procédés – Procédés de séparation et de réaction (Vol. 2, 5^e éd.). Paris : Dunod.																																

Module Title	Petrochemicals																																
Semester(s) in which the module is taught	Second Semester																																
Person responsible for the module	Dr Sahar RAISSI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons,																																
Workload (including contact hours, selfstudy hours)	Total workload: 21h Contact hours 21h : Course: 21h . Private study including exam preparation: 70h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in organic chemistry, particularly hydrocarbon structures and reactions, as well as fundamental knowledge of chemical reaction engineering and thermodynamics. Students are also expected to have a basic understanding of industrial chemical processes, material and energy balances, and separation techniques commonly used in the chemical and petrochemical industries. Familiarity with catalytic processes and process flow diagrams is beneficial for comprehending the transformation of petroleum fractions into valuable chemical products.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X	X				X	X	X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X	X				X	X	X	X																							
Content	Petroleum products: properties and main outlets Main characteristics of commercial products, connection with their composition. Energy content, greenhouse gas emissions and other pollutants, footprint environmental. Consumption of petroleum products Environmental constraints and alternative fuels. Consumption trends by product and future prospects: drivers and obstacles The stages of refining Origins of oil, methods of supply simple refining diagram initial fractionation of crude oils, transformation processes following the refining criteria and mixing of the bases obtained. Main risks related to products and processes. Evolution of refining schemes and synergies with petrochemicals (objectives and advantages).																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	https://www.journals.elsevier.com/fuel "Chemistry of Petrochemical Processes" – Sami Matar & Lewis F. Hatch "Petrochemicals: The Rise of an Industry" – Peter H. Spitz "Handbook of Petrochemicals Production Processes" – Robert A. Meyers																																

Module Title	Physico-chemical analysis of medicines																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr Fathi OUSLATI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, practical work																																
Workload (including contact hours, selfstudy hours)	Total workload: 35h Contact hours 35h : Course: 21h , PW: 14h. Private study including exam preparation: 55h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in analytical chemistry, pharmaceutical chemistry, and basic knowledge of instrumental techniques such as spectroscopy and chromatography.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X	X	X	X	X	X	X	X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X	X	X	X	X	X	X	X	X																							
Content	Physicochemical analysis of drugs I - Applications of analytical methods - Applications of chromatographic methods - Applications in the UV-Visible and IR fields - potentiometric and coulometric applications - polarographic and voltammetric applications II- Structural chemistry of organic drugs deduction of structures from UV spectra, IR, MS, NMR problems III- Pharmacopoeia controls of raw materials (chemically defined and of plant origin) IV- Pharmacopoeia controls of finished products V- Development of an analysis method (dosage, search for impurities and products of degradations dissolution test). VI- Analytical validation VII- Stability studies: raw materials and finished products VIII- Microbiological analysis and toxicology:																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists" – David G. Watson "Aulton's Pharmaceuticals: The Design and Manufacture of Medicines" – Michael E. Aulton & Kevin M.G. Taylor "Principles and Practice of Analytical Techniques in Pharmaceutical Analysis" – Ashutosh Kar																																

Module Title	Food analysis																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr. LAGHA																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, practical work																																
Workload (including contact hours, selfstudy hours)	Total workload: 35h Contact hours 35h : Course: 21h , PW: 14h. Private study including exam preparation: 60h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in analytical chemistry, food chemistry, and basic knowledge of instrumental techniques such as spectroscopy and chromatography.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X	X	X	X	X	X			
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X	X	X	X	X	X																										
Content	Chapter I: Microbiological analysis of foods Chapter II: The factors that affect the growth of microorganisms and the different techniques of food preservation Chapter III: Food additives and mycotoxins as food risks Chapter IV: Food toxicants																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Food Analysis" – Suzanne Nielsen (Springer, 5e édition) "Introduction to Food Analysis" – Nielsen et al. "Food Analysis Laboratory Manual" – Suzanne Nielsen																																

Module Title	Water and wastewater treatment																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr. Hatem RADDEDI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, direct work, practical work																																
Workload (including contact hours, selfstudy hours)	Total workload: 49h Contact hours 49h : Course: 21h , DW: 14h, PW: 14h. Private study including exam preparation: 49h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in environmental engineering, microbiology, and basic knowledge of physicochemical and biological treatment processes.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X	X	X	X	X	X			
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X	X	X	X	X	X																										
Content	Chapter I: Microbiological analysis of foods Chapter II: The factors that affect the growth of microorganisms and the different techniques of food preservation Chapter III: Food additives and mycotoxins as food risks Chapter IV: Food toxicants																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	Wastewater Engineering: Treatment and Resource Recovery" – Metcalf & Eddy / George Tchobanoglous "Biological Wastewater Treatment: Principles, Modelling and Design" – M. Henze, M.C.M. van Loosdrecht, G.A. Ekama, D. Brdjanovic "Water and Wastewater Technology" – Mark J. Hammer & Mark J. Hammer Jr.																																

Module Title	Treatment and valorization of solid wastes																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr. Mohamed JAZIRI and Zouhaier KSIBI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, Practical work																																
Workload (including contact hours, selfstudy hours)	Total workload: 35h Contact hours 35h : Course: 21h , PW: 14h. Private study including exam preparation: 54h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in environmental science, chemistry, and basic knowledge of waste management technologies and material recovery processes.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td></td><td>X</td><td>X</td><td></td><td></td><td></td><td></td><td>X</td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11		X	X					X			
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
	X	X					X																										
Content	1- Definitions - Types - Hazardous waste 2- Characterisation of hazardous waste 3- Methods for characterising toxic and hazardous residues 4- Toxic and hazardous waste management 5- Treatment and scrapping of hazardous waste 6- Waste exchanges and waste recyclers - Waste recyclers 7- Waste recovery and recycling 8- What waste and what treatment strategies? 9- Household waste issues 10- Technical landfill centres (general principles, leachate treatment, biogas treatment) 11- Thermal treatments (Incineration, general principles and theoretical aspects, Pyrolysis) 12- Biological treatment (composting, methanisation) 13- Waste stabilisation (stabilisation using hydraulic binders, vitrification)																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Solid Waste Engineering" – P. Aarne Vesilind, William Worrell & Debra Reinhart "Integrated Solid Waste Management: Engineering Principles and Management Issues" – George Tchobanoglous, Hilary Theisen, Samuel Vigi "Handbook of Solid Waste Management" – Frank Kreith & George Tchobanoglous																																

Module Title	Organic materials analysis																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr. Mohamed JAZIRI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, Practical work, Personal practical work																																
Workload (including contact hours, selfstudy hours)	Total workload: 42h Contact hours 35h : Course: 21h , PW: 14h, PPW: 7h. Private study including exam preparation: 55h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in organic chemistry, instrumental analysis, and basic knowledge of spectroscopic and chromatographic techniques.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td></td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11			X	X		X	X	X			
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
		X	X		X	X	X																										
Content	General information on polymers Polymer thermodynamics: Techniques for determining molecular weight Amorphous state and glass transition The crystalline state Melt rheology																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Organic Structure Analysis" – Phillip Crews, Jaime Rodríguez, Marcel Jaspars "Polymer Analysis" – Barbara H. Stuart "Organic Materials for Photonics: Design, Synthesis and Applications" – I. Rau et al.																																

Module Title	Inorganic materials analysis																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr. LAABIDI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, practical work, personal practical work																																
Workload (including contact hours, selfstudy hours)	Total workload: 42h Contact hours 35h : Course: 21h , PW: 14h, PPW: 7h. Private study including exam preparation: 56h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in inorganic chemistry, analytical chemistry, and fundamental knowledge of instrumental techniques such as spectroscopy, diffraction, and thermal analysis.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td></td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X		X	X		X	X	X		X	
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X		X	X		X	X	X		X																								
Content	1- Introduction to industrial inorganic chemistry 2- Chemical metallurgy 3- The basics 4- Acids: 5- Cements (Types, artificial Portland' Stages of manufacture aluminous cements, lime, plaster). 6- Fertilisers (fertilising elements, nitrogen fertilisers, potassium fertilisers, potassium chloride, compound fertilisers). 7- Glasses (definitions, manufacture of oxide glasses, sol-gel process, crisver process, special glasses, use). 8- Ceramics 9- Clean technology and environmental imperatives																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Characterization of Materials" – Elena Semouchkina "Analytical Techniques in Materials Conservation" – Barbara H. Stuart "Thermal Analysis of Materials" – Robert Speyer "Solid State Chemistry and its Applications" – Anthony R. West																																

Module Title	Metrology																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr. Chiraz HANNACHI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons																																
Workload (including contact hours, selfstudy hours)	Total workload: 21h Contact hours 21h : Course: 21h . Private study including exam preparation: 70h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in physics, mathematics, and basic knowledge of measurement principles, instrumentation, and uncertainty analysis																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X		X	X		X	X	X	X	X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X		X	X		X	X	X	X	X	X																							
Content	A) VALIDATION OF CALIBRATION AND ANALYSIS METHODS CHAPTER I: Study of the implementation of a new calibration and analysis method CHAPTER II: Verification tests of experimental data CHAPTER III: Approach to evaluating the characteristics of an analysis method CHAPTER VI: Evaluation of the robustness of an analysis method B) Estimation of uncertainties of calibration and analysis methods according to the GUM approach																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Introduction to Engineering Metrology" – K. J. Hume "Metrology for Engineers" – J.F.W. Galyer & C.R. Shotbolt "Measurement Uncertainty: Methods and Applications" – Ronald H. Dieck																																

Module Title	Entrepreneurial																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr. Nihel ZIADI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons, seminars																																
Workload (including contact hours, selfstudy hours)	Total workload: 21h Contact hours 21h : Course: 21h . Private study including exam preparation: 72h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	General culture, psychology, foundations of entrepreneurship and business startup.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td></td><td></td><td>X</td><td></td><td>X</td><td></td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X			X		X		X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X			X		X		X	X																							
Content	The content of the course is to learn students to :Identify the social, psychological and economic foundations of entrepreneurship - Describe the processes and realities of entrepreneurial action, as well as recognize the factors that contribute to sparking and developing the entrepreneurial spirit - Discover and develop their entrepreneurial potential																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	Lean Startup - Adoptez l'innovation continue by Eric Ries. The Art of the Start , by Guy Kawasaki																																

Module Title	Renewable energy and catalysis																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr. Zouhaier KSIBI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons.																																
Workload (including contact hours, selfstudy hours)	Total workload: 21h Contact hours 21h : Course: 21h . Private study including exam preparation: 75h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A solid background in physical chemistry, thermodynamics, and basic knowledge of catalysis, energy systems, and materials science.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X			X	X	X	X	X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X			X	X	X	X	X	X																							
Content	1) Renewable energies * Solar energy and applications: advantages and disadvantages *Wind energy and applications: advantages and disadvantages *Hydropower and its applications: advantages and disadvantages *Nuclear energy and applications: advantages and disadvantages *Geothermal energy and applications: advantages and disadvantages * Sustainable energy and clean energy. 2) Catalysis : * The role of catalysis in the degradation of toxic and non-biodegradable organic derivatives * Examples of reactions in which catalysis is used to limit air, soil and water pollution. * Catalytic pre-treatment of real effluents before the biological stage in waste water treatment. * Removal of heavy metals from water using copper catalysts deposited on clay. * Post-combustion catalysts in car exhausts and their effect on environmental pollution. * Visit to the FST Materials Chemistry and Catalysis Laboratory																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Renewable Energy: Power for a Sustainable Future" – Stephen Peake & Janet Ramage "Renewable Energy Engineering and Technology: Principles and Practice" – V.V.N. Kishore "Catalysis for Sustainable Energy Production" – Pierre Granger & J.-F. Lamonier (Springer) "Heterogeneous Catalysis in Sustainable Synthesis" – S. Behrens (ed.)																																

Module Title	Green chemistry and sustainable development																																
Semester(s) in which the module is taught	Third Semester																																
Person responsible for the module	Dr. Zouhaier KSIBI																																
Language	French																																
Relation to the curriculum	Mandatory																																
Teaching methods	Lessons.																																
Workload (including contact hours, selfstudy hours)	Total workload: 21h Contact hours 21h : Course: 21h . Private study including exam preparation: 69h																																
Credit points	3																																
Required and recommended prerequisites for participating in the module	A background in organic chemistry and sustainability concepts.																																
Module objectives/intended learning outcomes	<table><tr><td>SLO1</td><td>SLO2</td><td>SLO3</td><td>SLO4</td><td>SLO5</td><td>SLO6</td><td>SLO7</td><td>SLO8</td><td>SLO9</td><td>SLO10</td><td>SLO11</td></tr><tr><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr></table>											SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11	X	X	X		X	X	X	X	X	X	X
SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8	SLO9	SLO10	SLO11																							
X	X	X		X	X	X	X	X	X	X																							
Content	Chapter 1 : General information on the environment and pollution Chapter 2 : Chemistry and Health Chapter 3 : Sustainable development and environmental protection Chapter 4 : Recovering waste and pollutants Chapter 5 : Green chemistry and plant-based chemistry Chapter 6 : Soft and fine chemicals																																
Exam forms	Writing exam																																
Study and examination conditions	The student must have an overall average of at least 10/20																																
Reading list	"Green Chemistry: Theory and Practice" – Paul Anastas & John Warner "Introduction to Green Chemistry" – Albert Matlack "Green Chemistry and Engineering: A Practical Design Approach" – Concepción Jiménez-González & David Constable																																

Syllabus of the Engineering in Analytical Chemistry and Instrumentation Curriculum

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Energy

Chapter I: Reminders of Thermodynamics

- I. 1. Basic concepts and definitions
- I. 2. First law of thermodynamics
- I. 3. Second law of thermodynamics
- I. 4. Thermodynamic functions
- I. 5. Evolution and balance

Chapter II: Energy balances

- II.1. Thermal effects linked to physical phenomena
- II.2. Thermal effects linked to chemical transformations
- II.3. Applications: Thermal balance equation (temperature search flame, thermal balance of chemical reactor, etc.).
- II.4. Thermal machines (Motors, heat pumps and refrigerators).

Chapter III: Real gases

- III.1. Van Der Waals equation
- III.2. Real gas expansions (Joule-Gay Lussac, Joule Thomson)
- III.3. Corresponding States Theorem
 - III.3.1. Generalities of the Van Der Waals equation, reduced coordinates.
 - III.3.2. Average compressibility factor (third variable: factor acentric of pitzer)
 - III.2.3. Pitzer correlations (in Z^0 and Z^1 and B^0 and B^1)
- III.4. Applications
 - III.3.1. Presentation and use of the different charts ($Z(T_D P_r)$, $Z^0(T_D P_r)$, $Z^1(T_D P_r)$, $B^0(T_r)$ and $B^1(T_r)$).
 - III.3.2. Calculation of gas quantities in chemical reactors

Chapter IV: Fluid flow processes

- IV.1. Discontinuous flow.
- IV.2. Continuous flow.
- IV.3. Installation applications.

Thermodynamics of Solutions

Chapter I: Reminders on functions with several variables: Homogeneous functions.

I.2. Euler's theorems. Application: to the mass of a homogeneous system and the

internal energy function (U).

I.3. Gibbs-Duhem-Margulès (GDM) relationship.

I.4. Chemical potential of a constituent in its pure state.

Chapter II: What is a solution?

II.1. Composition of a solution: mass, molar fraction, concentration molar and molarity.

II.2. Thermodynamic quantities of a solution: global and molar.

II.3. Partial molar quantities of a substance in a solution.

II.4. Mixing quantities and access quantities.

II.5. Ideal solutions.

II.6. Chemical potential of a constituent in a real solution.

II.7. Case of very diluted real solutions: Raoult's law and Henry's law.

Chapter III: Equilibria between phases in ideal solutions and very dilute solutions

General expressions.

III.1. Solubility of a non-volatile solid: ideal and real solubility.

III.2. Cryoscopic lowering.

III.3. Osmosis and reverse osmosis.

III.4. Ebullioscopy.

III.5. Vapor Pressure of Solutions: Ideal Binary Diagrams liquid-vapor.

III.6. Formation of mixed crystals (solid solutions: Diagrams liquid-solid with full miscibility in the solid state)

III.7. Solubility of a gas: case of aqueous solutions.

Chemical kinetics and catalysis

Chapter I: Chemical reaction rate

I.1. Introduction

I.2. Definitions

I.2.1. Consumption rates of a reagent

I.2.2. Product formation speed

I.2.3. Overall reaction rate in a closed reactor

has. Reaction progress

b. Conversion rate

vs. Overall reaction speed

I.3. Experimental methods for measuring the reaction rate in a closed reactor

I.3.1. Chemical methods

I.3.2. Physical methods

I.3.3. Graphical determination of reaction rate

Chapter II: Speed equation – Concept of order

II.1. Introduction

II.2. Kinetic factors

II.3. Influence of the concentration of reagents

II.3.1. Velocity equation – Guldberg and Waage law

II.3.2. Determination of partial orders

has. Using the stoichiometric reagent mixture

b. Using order degeneracy

vs. Determination of partial orders

c.1. Integral method

c.2. Half-reaction time method

c.3. Differential method

II.3.3. Study of simple reactions

has. Zero order reaction

b. First order reaction

vs. Order 2 reaction

II.4. Influence of temperature on reaction rate

II.4.1. Introduction

II.4.2. Arrhenius' law

II.4.3. Energy diagram-Activation energy

Organic chemistry

Chapter I: Specific writing and Nomenclature

- I.1. Classification of organic compounds according to groupings functional
- I.2. Nomenclature of heterocyclic organic compounds

Chapter II: Stereochemistry

I.1. Static stereochemistry

- I.1.1. Conformation – Configuration
- I.1.2. Conformations of acyclic hydrocarbons
- I.1.3. Conformations of cycloalkanes
- I.1.4. Haworth representation, case of sugars and their derivatives
- I.1.5. Decalins, steroids and the anomeric effect
- I.1.6. Enantiomerism – Diastereoisomerism
 - has. Enantiomerism
 - a.1. Chirality criteria – Inverse symmetry axis
 - a.2. Optical activity
 - a.3. Absolute configuration (RS)
 - a.4. Relative configuration (erythro-threo)
 - at 5. Fischer's D, L nomenclature, case of sugars and amino acids
 - a.6. Axial chirality
 - b. Diastereoisomerism
 - b.1. Diastereoisomerism with several asymmetric atoms
 - b.1. Diastereoisomerism without asymmetric atoms
 - b.1. Diastereoisomerism π

I.2. Dynamic stereochemistry

- I.2.1. Enantiotopia – Diastereotopia
- I.2.2. Nomenclature of prochiral groups
- I.2.3. Prochiral faces and nomenclature

I.3. Resolution of a racemic compound

Chapter III: Electronic Effects

- III.1. Inductive effects
- III.2. Mesomeric effects
- III.3. Aromaticity
- III.4. Acidity – Basicity

Chapter IV: Reminder of reaction mechanisms

IV.1. Nucleophilic substitution reactions: SN1, SN2 and on carbon Sp2

IV.2. Electrophilic substitution reactions

IV.3. Elimination reactions: E1 and E2

IV.4. Electrophilic addition reactions

IV.5. Nucleophilic addition reactions

IV.6. Oxidation reactions

IV.7. Reduction reactions

TP Thermodynamics and kinetics

Manipulation No. 1 : Second order reaction, conductivity meter

Handling No. II: Kinetics of acetone iodination by spectrometry

Manipulation No. III: Determination of the activity energy of the reaction
hydrolysis acid, ethyl acetate

Handling No. IV: Determination of partial molar value

Handling No. V: Cryoscopic study of a dilute solution of a hydrocarbon
in solution in cyclohexane

Handling No. VI: Calorimetric study of a water-glucose mixture

Titrimetry

Chapter I: Oxidation-reduction assays

I.1. Reminders

Electrode potential, Influence of pH on electrode potential. Calculation of potentiometric titration curves, determination of the precision zone around the equivalence point. Turning zone of redox indicators.

I.2. Halogenimetry

I.2.1. Iodometry and Iodimetry

has. Preparation and calibration of iodine solutions.

b. Applications for the determination of thiols, antipyrine, salts
metal dosage of reducing sugars (Hage Dorn method
Jensen) etc.

vs. Determination of the iodine index.

d. Karl Fisher method

I.2. 2. Bromometry: Principle and application to the dosage of a few aromatic compounds (phenol sulfonamides, hydroxyquinoline, etc. Extension of the method to the determination of a few cations metallic (Al^{3+} , Mg^{2+} , etc.) .

I.2. 3. Chromimetry

has. Preparation and calibration of dichromate solutions
potassium.

b. Applications to the determination of ethanol: Nicloux method and Bertrand method. Determination of COD.

I.2. 4. Periodimetry

has. Preparation and calibration of metaperiodate solutions
sodium.

b. Applications to the determination of polyfunctional organic compounds (polyols, aminoalcols, specific amino acids, etc.): method of Malaprade and Fleury's method.

Chapter II: Complexometric dosages

II.1/ General information on complexes. Formation constants and constants conditional.

II.2. Use of Aminopolycarboxylic Acids in complexometry.

II.3. Calculates complexometric titration curves.

II.4. Turning zone of complexometric indicators.

II.5. The different complexometric drawing techniques: direct titration, return titration and displacement titration.

II.6. Complexometric dosage of mixtures: Influence of pH and masking on selectivity.

Chapter III: Acid-base dosages

III.1. General information on acid-base titrations

Preparation and calibration of acid and base solutions. Calculation of curves titration of weak ($pK_a < 8$) or very weak ($pK_a > 8$) acids. Determination of the precision zone. Dosage of polyacids and mixtures.

III.2. Aqueous protometry

Dosage of weak acids with $pK_a < 8$. Examples of dosage of weak acids of $pK_a > 8$: boric acid, determination of ammonium salts by the method by Kjeldahl. Extension of the Kjeldahl method to the determination of nicetamide.

Nitrite dosage. Dosage of esters: determination of the index of hydroxide.

III.3. Protometry in a non-aqueous medium

III.3.1. Autoprotolysis of amphi proton solvents. Ionic product.

Influence of the character of the solvent on the strength of acids and basics. Dosage of bases and very weak acids.

Chapter IV: Dosages by precipitation

IV.1. General information on precipitation titrations

Calculation of titration curves. Influence of the value of K_s on the shape of the titration curve. Dosage of mixtures.

IV.2. Mohr's method

Principle and conditions of use

IV.3. The method of Charpentier and Volhard

Principle and conditions of use.

IV.4. The Fajjens indicator

Applied Electrochemistry

Chapter I: Electrolytes

- I.1. Introduction
- I.2. Classification of electrolytes
- I.3. Ionization and dissociation
- I.4. Debye and Hückel theory
- I.5. Conductivity of ionic solutions
- I.6. Equivalent conductivity of ionic solutions
- I.7. Determination of ionic equivalent conductivities

Chapter II: General information on electrode processes

- II.1. Cell and electrochemical reactions
- II.2. Transfer of matter into solution
- II.3. Characteristic laws of electrochemical reactions

Chapter III: Intensity-potential curves

- III.1. Introduction
- III.2. Morphology of curves $i = f(E)$
- III.3. Shape of the curves $i = f(E)$
- III.4. Procedure for determining a curve $i = f(E)$
- III.5. Qualitative prediction of electrochemical reactions using curves $i = f(E)$

Chapter IV: Equation of the $I=f(E)$ curves of some fast systems

- IV.1. Introduction
- IV.2. Case of metal oxidation
- IV.3. Case of reduction of metal ions
- IV.4. Reduction of complexes to one drop of Hg
- IV.5. Case where we have a dissolved Ox and Red of the same redox couple in solution

Chapter V: Classic polarography

- V.1. Historical
- V.2. Principle of polarography
- V.3. Equipment
- V.4. Electrodes and areas of electroactivity
- V.5. Analytical application
- V.6. Application examples

Chapter VI: Impulse polarographic methods

VI.1. Limitations of classic polarography

VI.2. Pulsed polarography

VI.3. Pulsed methods

VI.4. Analytical application

VI.5. Application examples

Chemistry of Aqueous Solutions

Chapter I: Aqueous solutions

I.1. General

I.1.1. Composition of aqueous solutions,

I.1.2. Electrolyte solutions, Ostwald's dilution law.

I.2. Thermodynamic considerations

I.3. Calculation of activity coefficients

Chapter II: Acid-base balances

II.1. General

II.1.1. Definitions, Consequences of Brönsted's definition,

II.1.2. Acidity constant/Ionic product of water,

II.1.3. Strength of acids and bases,

II.1.4. Acid-base species predominance diagram.

II.2. Calculating the pH of aqueous solutions

II.2.1. Definition of pH

II.2.2. Approach followed for calculating the pH (classic method and leading reaction method),

II.2.3. Example of pH calculation, pH indicators.

II.3. Buffer solutions

II.3.1. Definition,

II.3.2. pH expression

II.3.3. Properties of buffer solutions, Effect of dilution, Effect of addition a strong base or a strong acid Buffering power,

II.3.4. Preparation of buffer solutions.

Chapter III: Solubility and precipitation-solubilization reactions

III.1. Solubility and saturation

III.1.1. Definition,

III.1.2. Liquid-solid equilibrium (Solubility product and Conditions of precipitation-solubilization).

III.2. Factors influencing solubility

III.2.1. Effect of temperature,

III.2.2. Effect of common ion,

III.2.3. Effect of complex formation,

III.2.4. Influence of pH,

III.2.5. Conditional solubility.

III.3. Applications of precipitation reactions

III.3. 1. Dosages

III.3. 2. Separations.

Chapter IV: Complexation reactions

IV.1. Definition, Highlighting of complexes, Nomenclature,

IV.2. Complexation reactions in aqueous solutions, Constant of stability

IV.3. Domain of predominance

IV.4. Complexation coefficient

Practical work in titrimetry and electrochemistry

Manipulation No. 1 : Dosage of EDTA

Handling No. II: Conductivity

Manipulation No. III: Fluoride dosage

Handling No. IV: Chromimetric dosage

Handling No. V: The complexes

Handling No. VI: Potentiometric dosage of Nikel

Functional Analysis in Organic Chemistry

Chapter I: Structure of organic molecules

- I.1. Constituent elements of organic compounds
- I.2. Crude formula and structural formula – number of unsaturation
- I.3. Centesimal analysis

Chapter II: Chemical tests

- II.1. Halogen drifts
 - II.1.1. Sodium iodide test
 - II.1.2. Beilstein test
 - II.1.3. Silver nitrate test
- II.2. Alkenes and alkynes
 - II.2.1. Bromine water test
 - II.2.2. Bayer test
- II.3. Alcohols
 - II.3.1. Sodium Test
 - II.3.2. Acetyl Chloride Test
 - II.3.3. Cerium ammonium nitrate test
 - II.3.4. Jones oxidation
 - II.3.5. Lucas test
 - II.3.6. Oxidation of carbohydrates by periodic acid
- II.4. Phenols
 - II.4.1. Liebermann Nitrosation Reaction
 - II.4.2. Pyridine-FeCl₃ test
 - II.4.3. Acetyl Chloride Test
 - II.4.4. Bromination Test
- II.5. Aromatic compounds
 - II.5.1. Azoxybenzene test
 - II.5.2. Chloroform and Aluminum Chloride Test
 - II.5.3. Sulfuric acid test H₂SO₄
- II.6. Carbonyls: Aldehydes and Ketone
 - II.6.1. Test at the DNPH
 - II.6.2. Hydroxylamine Hydrochloride Test: NH₂OH, HCl
 - II.6.3. SCHIFF reagent
 - II.6.4. FEHLING liqueur: Cu(Tartrate)₂²⁻
 - II.6.5. TOLLENS reagents: Ag(NH₃)₂⁺
 - II.6.6. Methylated ketones: Iodoform test
- II.7. Amines
 - Hinsberg test
- II.8. Amino acids
 - Ninhydrin test

Qualitative Analysis Inorganic

Chapter I: Reminder

I.1. Periodic classification of elements

I.1.1. Periodic table

I.2. Periodic classification (Topography – construction of TP)

Chapter II: General evolution of atomic properties

II.1. General evolution of the physical and chemical properties of the elements :

Ionization energy - Atomic radius - Attachment energy and electron affinity – Electronegativity – Metals, non-metals and metalloids – Periodicity in chemical properties of the elements (Periodic variation of the valence state – of the oxidation state – of properties redox)

II.2. Study of some families : Gr1 – Gr2 – Gr13 – 14-15-16-17

General properties – Chemical properties (Reactivity with: water, acid, base).

Chapter III: The salts

III.1. General information on the salt function: Definitions – Training – Acidic, basic, salt

neutral, complex and double – Salt displacement reactions (Temperature, pH, Precipitation and complexation).

III.2. Chlorides – nitrates – carbonates – sulfates.

III.3. Acid-base character of solutions salts.

Chapter IV: Oxides and hydroxides

IV.1. Oxides : Definitions (normal, peroxides, super oxides) –

Chemical properties and classification of oxides (acid-base – Lux Blud –structural).

IV.2. Hydroxides : General – Solubility of hydroxides – hydroxides non-metals (oxacids).

Chapter V: Inorganic quantitative analysis

V.1. Dissolving solid samples before analysis: Advantages – Disadvantages – ways to implementation solution.

V.2. Properties of commonly used acids: HCl, HNO₃, H₂SO₄, HF.

V.3. Practical etching techniques: metal sample – no metallic.

Chapter VI: Quantitative analysis of cations metallic

VI.1. General: Search systematic.

VI.2. Search for the cations of the first analytical (Hg^{2+} , Ag^{+} , Pb^{2+})

VI.3. Study of the fourth group of cations (Al^{3+} , Cr^{3+} , Fe^{3+})

VI.4. Study of the fifth group of cations (Zn^{2+} , Ni^{2+} , Co^{2+} and Mn^{2+})

VI.5. Analysis of alkalis (Na^{+} , K^{+}) and ion NH_4^{+}

VI.6. Analysis of group 2 and cations 3.

Chapter VII: Qualitative analysis of anions

VII.1. Search for group 1, 2 and anions 3.

Solid State and Metallurgy

Part I: Solid state

Chapter I: Symmetry

- I.1. Symmetry of finished figs
 - I.1.1. Symmetry operations
 - I.1.2. Category of operations
 - I.1.3. Equivalent points
 - I.1.4. Identities between operations
 - I.1.5. Coexistences of symmetry elements
 - I.1.6. Ad hoc groups
- I.2. Symmetry of infinite periodic figs
 - I.2.1. Symmetry operations
 - I.2.2. Translation groups
 - I.2.3. Crystal systems and networks
 - a. 2D system
 - b. 3D system

Chapter II: Crystallized solids: from the ionic model to the compound iono-covalent

- II.1. Ionic bonding in inorganic chemistry
 - II.1.1. Formation of the ionic bond
 - II.1.2. Properties of ionic substances
- II.2. Structural characters of ionic solids
 - II.2.1. Reminder of the description of compact stacks: cfc, hc
 - II.2.2. MX type ionic solids
 - has. Cubic anion lattice: CsCl
 - b. CFC anion networks: NaCl, ZnS-blende
 - vs. Hexagonal anion array: NiAs, ZnS-wurtzite
 - II.2.3. MX₂ type solids
 - has. Structure corresponding to the occupation of the sites cubic: Fluorine type (CaF₂) and antfluorine
 - b. Structure corresponding to the occupation of octahedral sites:
Rutile (TiO₂), Two-dimensional structure: CdCl₂ type, CdI₂
- II.3. Structural characters of more complex solids
 - II.3.1. MO₃ type compounds
 - II.3.2. AMO₃ type compounds
 - has. Compounds with a corundum type structure α -M₂O₃ (M³⁺ = Al³⁺, Cr³⁺, Ti³⁺, V³⁺, Fe³⁺)
 - b. Compounds of the CaTiO₃ perovskite type
 - II.3.3. Spinel-type AM₂O₄ compounds

II.4. Pauling's rules

II.5. Energy of ionic crystals

II.5.1. Direct method

II.5.2. Born-Fajans-Haber cycle

Chapter III: Non-stoichiometric solids

III.1. Real solid solutions

III.1.1. Solid integration solutions (SSI)

III.1.2. Gap solid solutions

III.2. Identification of solid solutions

III.2.1. Methodology

III.2.2. Principle

has. Case of a solid substitution solution (SSS)

b. Case of a solid insertion solution (SSI)

vs. Case of a lacunar solid solution (SSL)

III.3. Defects in solids

III.3.1. Classification of defects

III.3.2. Occasional faults

III.3.3. Defects in a stoichiometric compound

has. Schottky defects

b. Frenkel's Flaws

III.3.4. Defects in a non-stoichiometric compound

has. Substoichiometric compounds

a.1. Compounds with anionic vacancies

a.2. Interstitial cation compounds

b. Super-stoichiometric oxides

b.1. Compounds with cationic vacancies

b.2. Compounds with interstitial anions

Chapter IV: The Oxides

IV.1. Different types of oxides

IV.2. Classification of oxides

IV.2.1 Structural classification of oxides

has. Structure of low-valent metal oxides (ionic oxides)

b. Structure of high-valent metal oxides

vs. Non-metal oxides

IV.2.2. Classification of oxides based on their acidic properties

basic in aqueous media

has. Basic oxides

b. Acid oxides

vs. Amphoteric oxides

d. Neutral oxides

Part II: Metallurgy – Physico-chemistry of development

Chapter I: Study of ore

- I.1. Introduction**
- I.2. Ore study method**
- I.3. Examples of mineral studies**
 - I.3.1. Iron ores**
 - I.3.2. Aluminum ores**
 - I.3.3. Nickel ore**

Chapter II: Physical treatments of ores

- II.1. Preliminary treatment**
 - II.1.1. sorting**
 - II.1.2. crushing and grinding**
 - II.1.2. particle size classification**
 - II.1.3. classification control**
- II.2. Physical treatment**
 - II.2.1. densimetric classification**
 - II.2.2. flotation grading**
 - II.2.3. magnetic filing**
 - II.2.1. electrostatic classification**

Chapter III: Chemical treatment of ores

- III.1. Oxide treatment**
 - III.1.1. alkaline attack**
 - III.1.2. acid attack**
 - III.1.3. halogen attack**
 - III.1.4. lime attack**
- III.2. Sulphide treatment**
 - III.2.1. General**
 - III.2.2. Roasting of sulphide ores**
- III.3. Treatment of carbonates and sulfates**
 - III.3.1. General**
 - III.3.2. Examination of some special cases relating to carbonates**
 - III.3.2. Examination of the dissociation of some sulfates**

Chapter IV: Elaboration of metal

- IV.1. Introduction**
- IV.2. General information on thermal metallurgy**
 - IV.2.1. Reminder of thermodynamic data**
 - IV.2.2. The reduction reaction**
- IV.3. The free oxide reduction reaction**
 - IV.3.1. generalities**
 - IV.3.2. Ellingham diagram: $\Delta_r G^\circ(T) = f(T)$**
 - IV.3.3. Study of a reduction reaction**

- IV.3.4. Choice of reducer
- IV.3.5. Reduction by carbon and carbon monoxide
- IV.3.6. Hydrogen reduction
- IV.3.6. Metallothermy
- IV.4. The reduction reaction of bound or dissolved oxides
 - IV.4.1. Oxides chemically bonded in an oxygenated compound or in a mixed oxide
 - IV.4.2. Oxides in solution
- IV.5. The Halide Reaction
 - IV.5.1. Reduction of fluorides
 - IV.5.2. Chloride reduction
- VI.6. Characteristics and classification of thermal metallurgies
 - IV.6.1. Metal Reactivity
 - IV.6.2. Nature of the reducing agent
 - IV.6.1. Reduction temperature
- IV.7. Examples of thermal metallurgy
 - IV.7.1. Reduction by carbon monoxide or carbon
 - has. Iron metallurgy
 - b. Zinc metallurgy
 - vs. Copper metallurgy
 - IV.7.2. Hydrogen reduction
 - has. General
 - b. Preparation of molybdenum
 - vs. Preparation of tungsten
 - IV.7.3. Metallothermy
 - has. General
 - b. Preparation of chromium by aluminothermy
 - vs. Production of magnesium. “Magnetherm” process
 - IV.7.4. Electrochemical metallurgy
 - has. Electrolysis in aqueous solution
 - a.1. General
 - a.2. Characteristics of electroplated metal
 - b. Igneous electrolysis
 - b.1. General
 - b.2. Electrochemical preparation of aluminum

Chapter V: Refining

- V.1. General
- V.2. Purification methods
- V.3. Refining by liquation
- V.4. Refining by oxidation
 - V.4.1. Study of oxidation conditions
 - V.4.2. Study of oxide elimination
 - V.4.3. Nature of the oxidant
 - V.4.4. Deoxidation

- V.5. Cast iron refining**
 - V.5.1. Problem position**
 - V.5.2. Thermodynamic data**
 - V.5.3. The refining operation**

Chapter VI: Refining-superrefining-High purity metals

- VI.1. Thermal processes**
 - VI.1.1. Distillation or sublimation of metal**
 - VI.1.2. Volatilization of impurities**
 - VI.1.3. Zone Merge**
- VI.2. Chemical processes**
 - VI.2.1. Formation and decomposition of volatile compounds**
 - VI.2.2. Elimination of impurities by chemical reaction**
- VI.3. Electrochemical processes**
 - VI.3.1. Aqueous route**
 - VI.3.2. Igneous way**

Chapter VII: Shaping of metals and alloys

- VII.1. Forging**
- VII.2. Lamination**
- VII.3. Spinning**
- VII.4. Stamping**
- VII.5. Welding**
 - VII.5.1. Properties of weldments**
 - VII.5.2. Weld control**
 - VII.5.3. Weldability of metals and alloys**
- VII.6. Sintering of metallic materials**
 - VII.6.1. Simplified sintering theory**
 - VII.6.2. Liquid phase sintering**
 - VII.6.4. Methods for studying sintering**

Practical Organic Functional Analysis

Handling No. I : Laboratory Safety

Handling No. II : Purification of cyclohexanone

Handling No. III : Functional group tests

Handling No. IV : Esterification reaction

Handling No. V : Preparation of acetanilide

Handling No. VI : Preparation of parabromoacetanilide

Practical Inorganic Qualitative Analysis

Handling No. I : Analysis methods (I):

Thermal analysis - Ion exchange (Resin) - Dosage gravimetric (SO_4) - Complexometric dosage of Zinc.

Handling No. II : Methods of analysis (II): Determination of chlorides –

Dosage of calcium and magnesium in water – Dosage iodometric of ClO^- - Determination of carbonates.

Handling No. III : Poorly soluble salts

Handling No. IV : Hydroxides

Handling No. V : Sulphides

Handling No. VI : Analytical reactions

Handling No. VII : Cation analysis (I)

Handling No. VIII : Cation analysis (II)

Handling No. IX : Anion analysis

Handling No. : Qualitative and quantitative analysis

Session No.XI and No.XII: Examination

Spectroscopic Methods Analysis

Chapter I: General principles

- I.1.** Electromagnetic spectrum
- I.2.** Interaction of electromagnetic radiation with matter
- I.3.** Moment of transition. Selection rules
- I.4.** Law of absorption

Chapter II: Infra-red absorption spectroscopy

- II.1.** Theoretical notions (Case of diatomic molecules): vibrations harmonics and anharmonics; notions of force constant; rules of selection
- II.2.** Vibrations of polyatomic molecules: vibration modes; rule $3N - 6$; notions of group vibration and limitations; factors influencing the frequency and intensity of an IR band
- II.3.** Concepts on IR, conventional and Fourier transform equipment; intensity of IR bands; sample preparation
- II.4.** Application of IR spectroscopy to structural analysis
- II.5.** Application of IR spectroscopy to quantitative analysis
- II.6.** Basics of RAMAN spectroscopy; IR – RAMAN complementarity
- II.7.** IR derived spectra: Principle and applications

Chapter III: UV-VISIBLE ABSORPTION SPECTROSCOPY

- II-1 :** General concepts: electronic states and transitions of a molecule
- II-2 :** Equipment and band intensity; Beer-Lambert law
- II-3 :** Structural influences on the main chromophores
- II-4 :** Application of UV-Visible spectroscopy to structural analysis and quantitative
- II-5 :** Derived UV-Visible spectra: applications

Chapter IV: PHOTOELECTRONIC SPECTROSCOPY ESCA

- IV-1 :** Basic principles and foundations of XPS photoelectron spectroscopies (or ESCA) and UPS.
- IV-2 :** Instrumentation
- IV-3 :** Obtaining and interpreting the photoelectron spectrum.
- IV-4 :** Applications of ESCA to quantitative and qualitative chemical analysis, determination of the chemical composition of surfaces and the study of surfaces and interfaces.

Module: GM1.4 VH: 21 C + 21 TD

Analysis by atomic absorption and emission

- General Introduction.

Part I: Atomic absorption spectrometry:

Chapter I: Atomic absorption spectrometry with flame.

Chapter II: Disturbances of absorption spectrometry atomic.

Chapter III: Electrothermal atomic absorption spectrometry.

Chapter IV: Analysis of the elements and mercury

IV.1. Analysis of elements using the method of generating Hydrides coupled with absorption spectrometry atomic

IV.2. Analysis of mercury by absorption spectrometry atomic in cold vapor.

IV.3. Applications:

IV.3.1. ISO international standards.

IV.3.2. Scientific articles.

IV.3.3. Analytical problems.

Part II: Atomic Emission Spectrometry:

Chapter I Introduction: The different sources of excitation

I.1. Sources suitable for the analysis of *liquids* (flame and plasma),

I.2. Sources suitable for the analysis of *solids* (arc and spark).

Chapter IV: Flame atomic emission spectrometry.

Chapter V: Atomic emission plasma spectrometry (AES-ICP).

V.1. Applications:

V.1.1. ISO international standards.

V.1.2. Scientific articles.

V.1.3. Analytical problems.

Module: GM1.4 VH: 28 TP

Practical work Molecular spectroscopy

Manipulation No. 1 : atomic spectroscopy

Helium emission spectrum

Handling No. II : Electron spectroscopy

Ultraviolet

Visible-spectrometric assay

Handling No. III : Infra-red spectroscopy

Diatomic Molecule

Introduction - quantitative analysis

Application of infrared

TP Emission Spectrometry and Atomic Absorption

Handling No. I: Determination of copper by absorption spectrometry atomic with flame.

Manipulation No. II: Calcium dosage by absorption spectrometry atomic flame: Study of the interaction between the element to be measured (Calcium) and the element disturbing (Aluminium) in different environments (HNO_3 ; HCl).

Manipulation No. III: Dosage of sodium by absorption spectrometry and atomic emission with flame.

Manipulation No. IV: Dosage of zinc by absorption spectrometry atomic with flame in a complex matrix: application of the metered addition method.

Handling No. V: Determination of mercury by absorption spectrometry atomic in cold vapor

Handling No. VI: Dosage of some elements in drinking water by atomic emission spectrometry with plasma torque by induction

(According to the international standard ISO 11885)

This manipulation is carried out at the National Institute of Research and Physico-chemical Analysis in Sidi Thabet as part of a study visit.

Module: GM1.5 VH: 21 C + 21 TD

Probability and Statistics

Part 1: Probabilities

Chapter I: Probability space

- I.1. General (Vocabulary)
- I.2. Probabilities
- I.3. Conditional probabilities – independence

Chapter II: Discrete random variables

- II.1. Generalities and definitions
- II.2. Usual laws of probability (examples)
- II.3. Expectation of a random variable

Chapter III: Real random variables

- II.1. Density of a random variable (examples of laws)
- II.1. Distribution functions
- II.1. Normal law

Chapter IV: Limit theorems and approximations

- II.1. Classical inequalities convergences
- II.1. law of large numbers
- II.1. Moivre-Laplace theorem. Central limited theorem

Part 2: Statistics

Chapter I: Descriptive statistics for a single variable

- II.1. Vocabulary
- II.1. Graphical representations
- II.1. Digital summaries

Chapter II: Descriptive statistics for two variables

- II.1. Two quantitative variables
- II.1. Qualitative quantitative crossing
- II.1. Two quantitative variables
- II.1. Graphic Representation

Chapter III: Estimate

- II.1. General. Characteristic properties
- II.1. Point estimates and confidence intervals
- II.1. Method of moments. Maximum likelihood method
- II.1. Some usual estimates: frequency, average, variance...

Module: GM1.5 VH: 21 C

Computer science: Programming in C language

Reference: Programming in C language with corrected exercises, Claude Delannoy
programming in language, C JM Rigaud – A SAYAH

Chapter I: General information on the C language

I.1. Presentation by example of some C language instructions

I.1.1. an example of a program in C language

I.1.2. Structure of a program in C language

I.1.3. Declarations

I.1.4. to write information: the printf function

I.1.5. to do a repetition: the for statement

I.1.6. to read information: the scanf function

I.1.7. to make choices: the statement: if

I.1.8. directives to the preprocessor

I.2. Some writing rules

I.2.1. identifiers

I.2.2. keywords

I.2.3. the separators

I.3. Creating a program in C language

I.3.1. editing the program

I.3.2. the compilation

I.3.3. link editing

I.3.4. header files

I.4. basic types of C language

I.4.1. the concept of type

I.4.2. integer types

I.4.3. floating types

I.4.4. character types

I.4.5. initialization and constant

I.5. operators and expressions in C language

I.5.1. arithmetic operators in C language

I.5.2. relational operators

I.5.3. logical operators

I.5.4. ordinary assignment operators

I.5.5. increment and decrement operators

I.6. conversational input-output

I.6.1. the possibilities of the printf function

I.6.2. the possibilities of the scanf function

I.6.3. tutorial exercises

I.7. Control instructions

I.7.1. the statement: if

- I.7.2.** the switch statement
- I.7. 3.** the do,,,while statement
- I.7.4** the while statement
- I.7.5.** the for statement
- I.7.6.** tutorial exercises
- I.8.** The tables
 - I.8.1.** one-index tables
 - I.8.2.** multi-index tables
 - I.8.3.** initialization of arrays
 - I.8.4.** tutorial exercises

Module: GM1.5 VH: 42 TP

IT TP

Exercises to perform on the computer among the TD series

Module: GM1.6 VH: 21 C

French (expression technique)

Chapter I: Recruitment file

I.1. The motivation letter

COURSE

Outline of the cover letter (the essential sections)

Core of the cover letter: “You, me, we”

Objective of the cover letter (to seduce + encourage people to read the CV)

General advice: rules to apply + risks to avoid

T.D.

Study of some examples of targeted cover letters (spontaneous application + in response to an advertisement)

Studying a bad cover letter

Study of a good cover letter

Producing a cover letter

I.2. The Curriculum Vitae (CV)

COURSE

Outline of a CV (the essential sections)

Examination and deepening of each section separately

The photo that accompanies the CV

T.D.

Discovery of CV types (anti-chronological – per skills – mixed): advantages and disadvantages.

COURSE

Tips for shortening the CV

The CV in mini format: a tool of seduction

Mistakes to avoid

T.D.

Study of three CVs accompanied by opinions from recruitment experts.

I.3. The job interview

COURSE

Typical procedure for an interview

Tips for succeeding in a job interview

Five questions to ask at the end of the interview

Trick questions that the recruiter can ask

Questions feared by the candidate on his CV, on his weak and strong points, on his personality, etc.

T.D.

Viewing recruitment interview sequences (real + simulation) + general discussion.

I.4. The internship report

How to benefit from an internship?
Standard plan for an internship report
Writing (the essential sections)
Oral presentation of an internship report

Chapter II: Research presentation file (PFE, memory report, etc.)

II.1. The bibliography, citation and footnote

Discovery of international standards for the presentation of bibliographic addresses and the main Latin abbreviations most used in notes (“*ibid*”, “*op.cit*”, “*supra*”, “*infra*”, etc.).

Chapter III: Practical language file

III.1. Transcription of cardinal numeral adjectives in full

Batteries of exercises + Collective correction

III.2. Personal pronouns “en” and “y”

Batteries of exercises + Collective correction

III.3. Compound relative pronouns

Batteries of exercises on “which”, “which”, “which”, “from which”, “which”, “which” + Collective correction

III.4. Passive transformation

Batteries of exercises + Collective correction

III.5. The homophones “when”, “quant” and “qu’en”

Batteries of exercises + Collective correction

III.6. Adverbs in “amment” and “emment”

Batteries of exercises + Collective correction

III.7. The present subjunctive

Batteries of exercises + Collective correction

III.8. Summary of a scientific article

Distribution of documents and work in small groups. A protractor restores

Module: GM1.6 VH: 21 C + 21 TD

The first session:

Students are provided with a students' book prepared by the teacher. The book is divided up into 4 units. Each unit contains many related texts to the subject

Unit One: The History of Chemistry

Unit Two: Glasses and Plastics

Unit Three: Radioactivity

Unit Four: Gases

In each lesson the four skills are integrated.

I. READING

- I.1.** Read physical descriptions of simple apparatus components
- I.2.** Read short passages and identify the main ideas
- I.3.** Identify the cohesive ties in scientific discourse
- I.4.** Identify the relationships between paragraphs
- I.5.** Scan a text for specific information
- I.6.** Read a text and transfer information (Tables, diagrams etc...)
- I.7.** Read charts and diagrams
- I.8.** Transfer information in charts and diagrams
- I.9.** Learn new vocabulary related to the field of chemistry
- I.10.** Review grammar points

II. SPEAKING

- II.1.** Work on correct pronunciation of technical terms
- II.2.** Know phonetic alphabet
- II.3.** Introduce oneself/someone else/department/faculty etc...
- II.4.** Describe an apparatus
- II.5.** Compare types of equipment
- II.6.** Use background knowledge to speak about the field
- II.7.** Ask questions about places/prices/safety measures etc...

III. LISTENING

- III.1.** Listen and follow instructions
- III.2.** Listen to figures and write them

- III.3.** Listen to conversations and identify participants/relationships/topics etc...
- III.4.** Listen to short experimental instructions
- III.5.** Listen and sum up
- III.6.** Listen and respond to questions
- III.7.** Listen and transfer verbal information to nonverbal information

IV. WRITING

- IV.1.** Master the basic mechanics of writing (Punctuation, paragraphing etc...)
- IV.2.** Transfer information from a table or diagram
- IV.3.** Guided writing
- IV.4.** Gap filling
- IV.5.** Use linkers appropriately
- IV.6.** Write description of simple apparatus
- IV.7.** Prepare and write two research papers (one on lab equipment and the second on chemical symbols: origin and meaning)

The second session: Oral presentations

The second session is devoted to oral presentations. Students are required to prepare a topic of their choice and present it in class. The aim of this session is to improve their speaking skills. Students learn how to take notes during a presentation, how to evaluate and ask questions.

Chapter No. I: Economic Science

- I.1.** definitions
- I.2.** Economic functions
- I.3.** economic agents
- I.4.** The major economic systems

Chapter No. II: Economic Growth

- II.1.** Definition
- II.2.** Measurement indicators: GDP, GNP...
- II.3.** The determinants of economic growth
- II.4.** Growth and development

Chapter No. III: Unemployment

- III.1.** Definitions
- III.2.** The causes of unemployment
- III.3.** Policies to combat unemployment

Chapter No. IV: Inflation

- IV.1.** Definitions
- IV.2.** Measurement indicators
- IV.3.** The causes of inflation
- IV.4.** Policies to combat inflation

Chapter N°V: The company and its environment

- V.1.** The definition of business
- V.2.** Stakeholders in the company
- V.3.** Business environment

Chapter N°VI: The strategic options of companies

- VI.1.** The specialisation
- VI.2.** Diversification
- VI.3.** Outsourcing
- VI.4.** Internalization
- VI.5.** Innovation
- VI.6.** The quality
- VI.7.** Mergers and Acquisitions
- VI.8.** Internationalization

Second Year

IC4

GM & MA	MODULES
GM2.1	Organic Materials
	Characterization and Analysis of Organic Materials
	Inorganic Materials
	TP Materials
GM2.2	NMR analysis
	Mass Spectroscopy Analysis
	X-ray diffraction analysis
	Thermal Analysis Methods
GM2.3	Separation Methods
	Chromatographic techniques
	Separation Methods TP
	Chromatographic TP
GM2.4	Pharmaceutical chemistry
	Biochemistry
	Pharmaceutical Chemistry TP
	TP Biochemistry
GM2.5	Electronic
	InstrumentationI
	InstrumentationII
	Metrology
	TP Instrumentation and Metrology
	Electronics TP
GM2.6	Computer Science Applied to Chemistry
	IT TP
	Communication techniques
	English
	Corporate culture
	Tutored project
TOTAL	

Module: GM2.1 VH: 42 C

Organic Materials

Chapter 1: General Introduction

- I.1.** Polymers and materials
- I.2.** Economic importance
- I.3.** Classification
- I.4.** First definitions (Monomer, monomer unit, degree of polymerization, homopolymer, copolymer, etc.)

Chapter 2: The polymer chain

- II.1.** Dimensionality and functionality
- II.2.** Macromolecular backbone structures
- II.3.** Types of sequence and stereochemistry
- II.4.** Bonds and interactions in polymers
- II.5.** Cohesion energy
- II.6.** Distribution of Molar Masses

Chapter 3: Supramolecular organization

- III.1.** Polymers in liquid state
- III.2.** Crystalline – liquid polymers
- III.3.** Solid-state polymers
 - III.3. 1.** Crystalline and semi-crystalline polymers
 - III.3. 2.** Amorphous polymers and glass transition
 - III.3. 3.** Crystallinity rate
 - III.3. 4.** Plasticity and elasticity of polymers
 - has.** Thermoplastics
 - b.** Thermosets
 - vs.** Elastomers
 - d.** Thermoplastic elastomers

Chapter 4: The main methods of macromolecular synthesis

- IV.1.** Classification of polymerization reactions
 - IV.1.1.** Craothers classification
 - IV.1. 2.** Flory classification
- IV.2.** General
 - IV.2.1.** Polycondensations and polyadditions
 - IV.2.2.** Chain polymerizations
 - IV.2.3.** Thermodynamic aspects

Chapter 5: Polycondensation and polyaddition reactions

- V.1.** General characteristics and examples
 - V.1.1.** Nature of the mechanism
 - V.1.2.** Difference between polycondensation and polyaddition
- V.2.** Polycondensations or polyadditions involving a single monomer of the type AB
- V.3.** Polycondensations or polyadditions involving 2 types of monomers

AA+BB

V.4. Control of the molar masses of linear polycondensates

V.4.1. Case of a stoichiometric mixture of 2 functional groups A and B

V.4.2. Case of a non-stoichiometric mixture of 2 functional groups A and B

V.5. Polycondensation kinetics

V.6. Polycondensation of multifunctional monomers “Gel point”

Chapter 6: Radical polymerization

VI.1. Introduction

VI.2. Mechanism

VI.3. Radical polymerization kinetics

VI.4. Kinetic chain length

VI.5. Transfer reactions

VI.6. Inhibition and delay reactions

VI.7. Trommsdorf-Norrish effect or freezing effect

VI.8. Radical copolymerization

Chapter 7: Anionic polymerization

VII.1. Introduction

VII.2. Polymerizability of monomers

VII.3. Polymerization conditions

VII.4. Mechanism (vinyl monomers and heterocycles)

VII.5. Polymerization kinetics

VII.6. Number average degree of polymerization

VII.7. Living polymerization

Chapter 8: Cationic polymerization

VIII.1. Introduction

VIII.2. Monomers used

VIII.3. Polymerization conditions

VIII.4. Mechanism (vinyl monomers and heterocycles)

Chapter 9: Coordination polymerizations (stereospecific)

IX.1. Introduction

IX.2. Brief History

IX.3. Ziegler Natta catalysts

IX.4. Mechanism for obtaining isotactic PP

Chapter 10: Industrial polymerization techniques

X.1. Bulk polymerization

X.2. Suspension or dispersion polymerization

X.3. Solution polymerization

X.4. Emulsion polymerization

Module: GM2.1 VH: 42 C

ORGANIC MATERIALS (POLYMERS)

First part: Macromolecules.

Chapter I: Different types of macromolecules.

I.1. Introduction basic definition.

I.2. Macromolecular interaction

I.3. Linear macromolecules.

I.4. Branched macromolecule.

I.5. Three-dimensional polymers.

Chapter 2: Main characteristics of macromolecules.

II.1. Structure of the monomer unit.

II.1.1. Geometry.

II.1.2. Polarity.

II.1.3. Binding energies.

II.2. Structural irregularities, isomerism.

II.2.1. Structural irregularities.

has. Branching out.

b. Chain ends.

vs. Internal structural irregularities.

II.2.2. Stereoisomers, tactical polymers.

has. Isotactic polymers.

b. Syndiotactic polymers.

vs. Atactic polymers.

II.3. Dimensions of macromolecules.

II.3.1. Definitions.

II.3.2. Methods for determining molecular masses.

II.4. Morphologies.

II.4.1. Amorphous polymers.

II.4.2. Semi-crystalline polymers.

II.4.3. Amorphous two-phase materials.

II.4.4. Case of three-dimensional macromolecules.

Chapter 3: Synthesis of macromolecular compounds.

III.1. Introduction - Classification of synthetic reactions.

III.2. Polymerase chain reactions.

III.2.1. Radical polymerizations.

III.2.2. Ionic or polar polymerizations.

III.3. Polymerization reactions.

III.3.1. Functionality – responsiveness of functional groupings.

III.3.2. Polycondensation of bifunctional monomers.

III.3.3. Polycondensation of multifunctional monomers-phenomenon of gelling.

Part two: Properties of polymers in the solid state.

Chapter1: Physical properties of polymers

I.1. Introduction

I.1.1. Various types of stress on a material.

has. Tensile or compressive stress

b. Shear stress

I.1.2. The liquid state.

I.1.3. The rubbery gap.

I.1.4. Polymers in the solid state.

I.2. Crystallinity of polymers.

I.2.1. Concept of Crystallinity in polymers.

has. Existence of different domains.

b. Morphology of crystal domains.

I.2.1. Determination of the crystallinity rate.

has. Density measurement.

b. Calorimetric measurement.

I.2.1. Element of crystallization kinetics.

has. Cooling rate.

b. Mechanical stress.

I.2.1. Influence of the chemical nature of the compound.

has. Chemical structure.

b. Stereoregularity.

vs. Reticulation.

Third part: The transformation of polymers.

Chapter I: Introduction – classification of polymers.

I.1. Calendering.

I.2. Extrusion.

I.3. Molding.

I.4. Extrusion and injection blow molding.

I.5. Thermoforming.

I.6. Rotomoulding.

I.7. Other methods of transformation.

Fourth part :Characteristic study of some common plastics.

Chapter I: Polyolefins, polyethylenes and polypropylenes PE, PP

I.1. Preparation.

I.2. Properties.

I.3. Fillers , reinforcements and additives .

I.4. Implemented.

I.5. Applications.

Chapter II: polyvinyl chlorides and their derivatives (PVC).

- II.1.** preparation.
- II.2.** properties.
- II.3.** fillers , reinforcements and additives .
- II.4.** Implemented.
- II.5.** Applications.

Chapter III: styrenics.

Chapter VI: polyacrylics (PMMA)

Chapter V: fluoropolymers.

Chapter VI: polyoxymethylenes (POM).

Chapter VII: polyamides (PA)

Chapter VIII: polycarbonates.

Chapter IX: thermosets: polyesters, polyurethanes, etc.

Fifth part: rubbers.
Sixth part: composites.

Inorganic Materials

Chapter 1: Elements of Materials Inorganic

- I.1. Introduction
- I.1. What is a material ?
- I.1. The main categories or classes of materials
- I.1. Properties of materials
- I.1. Economic data and resources
- I.1. Environmental aspects: Environmental impact, Recyclability

Chapter 2: Clays: Material First

- II.1. Introduction
- II.1. Definitions and Mineralogy of clays
- II.1. Classification of clay minerals (phyllosilicates)
- II.1. General properties of clay minerals (phyllosilicates)
- II.1. Evolution during treatment thermal
- II.1. Handling (or usage) properties: Use of clays in industry
ceramic

Chapter 3: The glasses

- III.1. History and definitions
- III.2. Chemical Composition of glasses
- III.3. Processes of manufacturing
- III.4. The properties of glasses
- III.5. Glass and Environment
- III.6. Glass industry in Tunisia

Chapter 4: The ceramics

- VI.1. Definitions
- VI.2. Uses
- VI.3. Structure of ceramics

Chapter 5: The cements

- V.1. Introduction, what is cement ?
- V.2. The industry cements
- V.3. Using the cement
- V.4. Cement manufacturing Portland
- V.5. Hydration of cements
- V.6. Cement and development sustainable

TP Materials

Manipulation No. I: Synthesis of a conductive polymer: polyaniline

Manipulation No. II: interfacial polycondensation

Manipulation No. III: Synthesis of PMMA and polystyrene by radical route

Handling No. IV: Physico-chemical characterizations of some polymers

Manipulation No. V: Differential scanning calorimetry

Module: GM2.2 VH: 42 C

NMR ANALYSIS

Chapter I: Nuclear magnetic resonance phenomenon

Chapter II: Main quantities measurable in NMR: δ , J

II-1: Correlation chemical shift - molecular structure

II-2: Constant correlation of scalar coupling - molecular structure

Chapter III: analysis of high resolution NMR spectra

III-1: Case of weakly coupled spin systems

III-2: Practical method for analyzing an AB system;

Examples of NMR spectra of strongly coupled systems

Chapter IV: NMR spectrometers

IV-1: Continuous wave NMR spectrometer

IV-2: Fourier transform NMR spectrometer

Chapter V: Double resonance and chemical shift reagents

Chapter VI: Examples of high-resolution NMR applications

IV-1: Chemical exchange; Effect of the presence of an asymmetric site,...

Chapter VII: Applications of NMR to quantitative analysis

IV.1. Optimal conditions for quantitative analysis

IV.2. Intra- and intermolecular standards

IV.3. dosages of mixtures

IV.4. determination of isotopic substitution rates, humidity, etc.

Chapter VIII: Multi-pulse and two-dimensional NMR experiment (Elementary notions)

VIII.1. Experiences

VIII.1.1. COZY,

VIII.1.2. DEPT,

VIII.1.3. INADEQUATE;

VIII.1.4. NOE, deT_1 , etc. measurement sequences

Chapter IX: Applications of NMR to the elucidation of structures molecular

Module: GM2.2 VH: 21 C + 21 TD

Mass spectrometry

Chapter I: Introduction to mass spectrometry

- I.1. Introduction**
- I.2. Concept of exact mass**
- I.3. Isotope and molar masses**
- I.4. Ionization of organic compounds**
- I.5. Principle of mass spectrometry**

Chapter II: Ionization by electronic impact

- II.1. Introduction**
- II.2. Principle of ionization by electronic impact**
- II.3. The main cuts of organic molecules**
- II.4. Specific alkane cuts**
- II.5. Specific cuts of alkenes**
- II.6. Specific cuts of alkynes**
- II.7. Specific alcohol cuts**
- II.8. Specific ether cuts**
- II.9. Specific cuts of aldehydes**
- II.10. Specific ketone cuts**
- II.11. Specific cleavages of carboxylic acids and esters**
- II.12. Specific cleavages of amides**
- II.13. Specific cuts of amines**
- II.13. Specific nitrile cuts**
- II.14. Specific nitro cuts**
- II.15. How to interpret a mass spectrum**

Chapter III: Other ionization methods

- III.1. Introduction**
- III.2. Why do we need alternative ionization methods**
- III.3. Chemical ionization**
- III.4. Electrospray ionization**
- III.5. MALDI ionization**
- III.6. DESI ionization**
- III.7. Examples of use**

X-RAY ANALYZES

Chapter I: X-ray fluorescence

- I.1.** Nature of X-rays
- I.2.** X-ray production
- I.3.** X-ray tubes
- I.4.** Radioactive sources
- I.5.** Matter-X-ray interactions
- I.6.** Absorption of X-rays by matter
- I.7.** Fluorescence X-ray emission
- I.8.** X-ray detection
- I.9.** Application areas
- I.10.** Radiation separation
- I.11.** Conducting an analysis

Chapter II: X-RAY DIFFRACTION

- II.1.** Basic principle of measurement - Powder method
- II.2.** Bragg-Brentano diffractometer
- II.3.** Debye-Scherrer Room
- II.4.** Specific assemblies
- II.5.** Qualitative analysis
- II.6.** Quantitative analysis

Chapter I: Introduction to thermal analysis methods presentation and convention

- I.1.** What is thermal analysis? Presentation of the different methods thermal analysis.
- I.2.** Experimental device for thermal analysis of different methods thermal analysis.
- I.3.** Fields of application of thermal analyses.

Chapter II: Thermogravimetry

- II.1.** Principle of thermogravimetry
- II.2.** Obtaining thermogravimetric curves (TG)
- II.3.** Main factors influencing the shape of TG curves
- II.4.** Coupling thermogravimetry with other analytical techniques (CPG, ATD and DSC)

Chapter III: Differential thermal analysis

- III.1.** Generality and principle
- III.2.** Limit direct thermal analysis
- III.3.** ATD curves, nomenclature and convention
- III.4.** Experimental apparatus
- III.5.** the Factors on which the ATD curves depend
- III.6.** Theoretical aspect, transfer and calculation of transformation heat
- III.7.** Application: ATD and the study of some minerals

Chapter IV: Calorimetry

- IV.1.** Generality and principle
- IV.2.** Different types of calorimetry: adiabatic, isothermal, isoperibotic and differential
- IV.3.** Differential scanning calorimetry (DSC)
 - IV.3.1** Experimental slide
 - IV.3.2** Factors on which DCS curves depend
 - IV.3.3** Curves, nomenclature and convention
 - IV.3.4** Application to the determination of transition temperatures allotropic or vitreous (T_g).

Chapter V: Calorimetry

- V.1.** Generality and principle
- V.2.** Dilatorntic measurement (different types of measurement)
- V.3.** Modification of the expansion coefficient.
 - V.3.1.** Material composition
 - V.3.2.** Loading magnetic state.
 - V.4.** Application: Study of some materials.

Module: GM2.3 VH: 21 C + 21 TD

Separation methods

Chapter I: Separation by selective precipitation

I.1. Presentation of separation methods:

The different methods (precipitation, extraction, ion exchange, distillation, chromatography methods, membrane processes), Importance and areas of application.

I.2. Solubilization precipitation of Molecules:

solubilization by complexation effect, Implementation of acid-acid reactions basic

I-3 Solubilization-Precipitation of metal salts and hydroxide:

Conditional Solubility Product, Selective Separation Conditions

I-4 Applications to separations: Exercises and Problems

Chapter II: Separation by ion exchange

II-1 Ion exchangers:

Structure of exchangers , Characteristics of exchangers (exchange capacity, bypass rate, swelling rate) .

II-2 Ion exchange balances:

Distribution coefficients (in the absence and presence of complexing agent), Selectivity coefficients, determination of equilibrium concentrations (in the ion exchanger and in the solution)..

II-3 Separation by ion exchange:

Simple equilibrium technique (conditions on distribution coefficients to carry out a selective separation), Chromatographic column (principle of development by elution and permutation)

II-4 Applications to separations: Exercises and Problems

Chapter III: Separation by liquid-liquid extraction

III.1. General:

Principle, Classifications of extraction methods .

III.2. Quantities used in extraction:

Quantities independent of the volume of the phases (distribution coefficients , extraction constants), Quantities involving the volume of the phases (Extraction factor, extraction yield)

III.3. Optimizing the yield of an extraction: Multiple extractions

III.4. Extraction of metal chelates: Extraction of chelates in the absence of complexing agent , variation of extraction yield with pH , prediction of extraction yield in the presence of complexing agent.

III.5. Applications to separations: Exercises and Problems

Chromatography

Chapter I: Chromatographic methods

I.1. General

I.1.1. Introduction

I.1.2. Historical

I.1.3. The interest of chromatography

I.2. Classification of chromatographic techniques

I.2.1. Classification according to the nature of the phases

I.2.2. Classification according to the chromatographic phenomenon

I.2.3. Classification according to the processes used (or packaging of the stationary phase)

I.2.4. Catalog of chromatographic techniques

has. Flowchart of chromatographic methods according to the three classes

b. Influence of phase polarity

vs. Interaction and parameters governing solute retention

I.3. Advantages of gas and liquid chromatography

I.3.1. Advantage of the GIC

I.3.2. Advantage of HPLC

I.4. The chromatogram

I.5. Fundamental quantities of chromatography

I.5.1. Properties of a Gaussian peak

I.5.2. Retention quantities

has. Retention time (t_R)

b. retention volume (V_R)

vs. Reduced retention times (t'_R)

I.5.3. Concepts of concentration

has. Partition coefficient (K)

b. Capacity factor (k')

vs. Selectivity (α)

I.5.4. Column efficiency

has. Number of theoretical plates (N_{th})

b. Number of effective trays

vs. Height equivalent to a theoretical plateau (HEPT)

d. Reduced sizes

I.5.5. Widening of peaks

has. Longitudinal molecular diffusion

b. Resistance to mass transfer

vs. Flow (flux) anisotropy

d. Knox relationship

e. Deemter's relationship

- I.5.6.** Resolution
- I.5.7.** Column pressure loss
- I.5.8.** Performance Index and Separation Impedance
- I.5.9.** Peak capacity

Chapter II- Gas chromatography

- II.1.** Introduction
- II.2.** Principle of CPG
 - II.2.1.** Summary description of a gas chromatograph
 - II.2.2.** The injector
 - II.2.3.** The oven
 - II.2.4.** Carrier gas
 - II.2.5.** The column
 - has.** Packed column
 - b.** Capillary column
 - vs. Column 530 μ m
 - II.2.6.** The stationary phase
 - has.** Liquid for stationary phase use
 - b.** Solid stationary phases
- II.3.** Detection
 - II.3.1.** The catharometer
 - II.3.2.** Flame ionization detector
 - II.3.3.** Thermionic detector
 - II.3.4.** Electron capture detector
 - II.3.5.** Flame photometric detector
- II.4.** Retention index and Kovats line
- II.5.** Stationary phase constants (McReynolds constant)

Chapter III- Liquid phase chromatography on column (Adsorption, partitioning, ion exchange, exclusion)

- III.1.** Introduction
- III.2.** Equipment
 - III.2.1.** Pumping system
 - III.2.2.** Gradient elution devices
 - III.2.3.** Injectors
 - III.2.4.** Detectors
 - III.2.5.** Column and stationary phases
 - III.2.6.** Solvents, eluent strength and polarity
- III.3.** Classic partition chromatography
- III.4.** Reverse-phase partition chromatography

III.5. Influence of different factors

III.5.1. Role of the stationary phase

- has.** Influence of the number of chains grafted per unit area on k' and α
- b.** Influence of the length of the chain on k' and α
- vs.** Influence of the hydrocarbon surface

III.5.1. Role of the mobile phase

III.5.1. Effect of grafting on efficacy

III.5.1. Influence of temperature

III.5.1. Influence of pH

Chapter IV- Optimization

VI.1. Introduction : The triangle of compromises: sensitivity, speed

VI.2. Optimization of quantities to inject

VI.3. Resolution Optimization

VI.3.1. Optimization by the separation factor α

VI.3.2. Optimization by the retention factor

VI.3.3. Optimization by the number of trays

has. Influence of the speed of the mobile phase

b. Influence of particle diameter

vs. Influence of the geometric characteristics of the column

VI.4. Optimization by mobile phase speed

VI.5. Optimization of analysis time and pressure loss

VI.6. Multi-parameter optimization

Chapter V- Size exclusion chromatography

V.1. Introduction

V.2. Principle

V.3. Retention of solutes in GPC

V.4. Retention mechanism

V.4.1. Adsorption

V.4.2. Liquid - liquid sharing

V.4.3. Steric exclusion

V.5. GPC column

V.5.1. Features

V.5.1. Widening of peaks

V.5.1. Column calibration

V.6. Applications

Chapter VI- Ion exchange chromatography

VI.1. Definitions

VI.2. Ion exchangers

VI.2.1. Functional grouping

VI.2.2. Retention mechanism

VI.2.3. Fine-tuning of the mobile phase

has. pH value

b. Ionic strength

vs. Nature of the developer ion

d. Examples

VI.3. Ion pair chromatography

VI.3.1. Principle

VI.3.2. Practical aspect

TP Separation method

Manipulation No. I: Selective precipitation.
Separation of iron III, copper II and zinc ions.

Manipulation No. II: Separation by ion exchange.

Manipulation No. III: Separation of cations using ion exchange resins.

Manipulation No. IV: Separation by extraction.
Extraction of metal chelates.

Handling No. V: Separation of iron and aluminum by extraction of chelates.

TP Chromatographic methods

Manipulation No. I: Identification of the colorings of a mint syrup by column chromatography

Handling No. II: Thin layer chromatography of amino acids

Manipulation No. III: Gas chromatography

Handling No. IV: High performance liquid chromatography (HPLC)

Manipulation No. V: Ion chromatography: Analysis of the cations present in the natural waters

PHARMACEUTICAL CHEMISTRY

Chapter I: Introduction to knowledge of medicine

- I.1. Introduction
- I.2. Definition
- I.3. Origin
- I.4. Denomination
- I.5. Generics

Chapter II: Bioisosteres

- II.1. Active substances
- II.2. Excipients

Chapter III: Structure-Activity Relationship

Chapter VI: The main therapeutic classes of drugs

- VI.1. Of natural origin
- VI.2. Of synthesis
- VI.3. Some examples of therapeutic classes of major interest
 - VI.3.1. Painkillers
 - has. Morphine central analgesics
 - b. Non-morphine central analgesics
 - vs. Peripheral analgesics
 - VI.3.2. Antibiotics
 - has. – lactams
 - a.1. Penicillins
 - a.2. Cephalosporins
 - b. Aminosides or oligosides
 - vs. Tetracyclines
 - d. The phenicols
 - e. Sulphonamides
 - VI.3.3. Heart conditions
 - has. Anti-hypertensives
 - b. Anti-arrhythmics
 - VI.3.4. Psychotropic drugs
 - has. Neuroleptics
 - b. Anti-depressants

Biochemistry

Chapter I: Structural Biochemistry

General introduction: definition of biochemistry, chemical composition of biological matter

I.1. Carbohydrates

I.1.1. Classification, structures, uses and use derivatives, oligosides (example; sucrose, maltose, lactose), polysaccharides (examples; starch, glycogen and cellulose), glycosides.

I.1.2. Physical and chemical properties (main reactions)

I.1.3. Dosage

I.2. Lipids

I.2.1. Classification, Structures, fatty acids, alcohols, simple lipids and complexes, isoprene lipids,...

I.2.2. Physical and chemical properties

I.3. Nucleic acids

I.3.1. Structures of free nucleosides and nucleotides in DNA and RNA

I.3.2. Isolation and dosage

I.4. The proteins

I.4.1. Structures and classification: amino acids, peptides, polypeptides, sequences, the different levels of structural organization.

I.4.2. Purification and dosage

Chapter II: Metabolic biochemistry and enzymology

II.1. Primary and secondary metabolism, the main metabolic pathways oxidative and fermentative

II.1. Introduction to general enzymology

II.1.1. Properties of enzymes

II.1.2. Enzyme reactions and kinetics

Chapter III: Applied biochemistry

III.1. Processing of organic products

III.1.1. Biochemical transformations

III.1.2. Enzymes and applications

III.2. Main agri-food, industrial, medical and Pharmaceutical Biochemistry

Pharmaceutical Chemistry TP

Handling No. I: Synthesis of a preservative: propylparaben

Manipulation No. II: Preparation of acetylsalicylic acid (aspirin)

Manipulation No. III: Preparation of paracetamol

Manipulation No. IV: Dosage of a doliprane tablet

Handling No. V: Preparation of phenacetin

Manipulation No. VI: Preparation of phenylacetone

Biochemistry practical work

Manipulation No. I: Electrophoresis of amino acids on paper
Colorimetric determination of soluble proteins by the method
by lowry

Manipulation No. II: Calibration of a glucose + fructose solution
Kinetic study of baker's yeast invertase: $P = f(t)$

Manipulation No. III: Influence of substrate concentration on activity
baker's yeast invertase

Manipulation No. IV: Lipids: Determination of molecular weight and degree
unsaturation of triolein.

Manipulation No. V: Carbohydrates: Identification of sugars by chemical reactions
specific.

Metabolism: Intervention of nicotineamide-adenine
dinucleotide (NAD) in metabolic pathways

Module: GM2.5 VH: 21 C + 21 TD

Analog electronic

Chapter I: General theorems

- I.1. Kirchhoff's laws
- I.2. Superposition theorem
- I.3. Thévenin's theorem
- I.4. Norton's theorem
- I.5. Millman's theorem
- I.6. Kennely's theorem

Chapter II: Quadrupoles and linear filters

- II.1. Introduction to electrical networks.
- II.2. Concept of quadrupoles.
- II.3. Parameters of a Quadripole.
- II.4. Filter concept.
- II.5. Different types of filters; Low Pass, High Pass, Band Pass, Band Cut.
- II.6. First order filter.
- II.7. Bode diagram.

Chapter III: Diodes and Diode Circuits

- III.1. Concept of Semiconductors.
- III.2. Junction Diode, Characteristics and modeling of a diode.
- III.3. Diode circuits: Single-wave rectification, Double-wave rectification, Filtering, eliminator circuits,....
- III.4. Zener diode

Chapter IV: Bipolar transistor

- IV.1. Structure of Transistors.
- IV.2. Static characteristic in Common Emitter mode.
- IV.3. Polarization of a transistor.
- IV.4. Bipolar transistor in alternating mode.
- IV.5. Bipolar Transistor Amplifier

Chapter V: FIELD EFFECT TRANSISTOR

- V.1. Presentation of the JFET.
- V.2. How JFET works
- V.3. Static characteristic of the field effect transistor.
- V.4. Polarization circuits.
- V.5. Equivalent scheme in variable regime.
- V.6. Field Effect Transistor Amplifier.

Chapter VI: OPERATIONAL AMPLIFIER

VI.1. General.

VI.2. Amplifier Mounts

VI.3. Mathematical functions (differentiator, integrator, adder, Subtractor,...)

Instrumentation I

CHAPTER I: Characteristics of measure

- I.1. Static metrological characteristics.**
 - I.1.1. Span,**
 - I.1.2. calibration curve**
 - I.1.3. Precision**
 - I.1.4. Zero offset,.....**
- I.2. Dynamic characteristics;**
 - I.2.1. Zero order system**
 - I.2.2. First Order System**

CHAPTER II: ANALOG MEASURING DEVICES

- II.1. Definition of a measuring device.**
- II.2. Magnetoelectric devices.**
- II.3. Ferromagnetic devices.**
- II.4. Electrodynamics devices.**
- II.5. Devices for measuring electrical quantities; Voltmeter, Ammeter.**

CHAPTER III: THE SENSORS

- III.1. General.**
- III.2. Active Sensors:**
 - III.2.1. Thermoelectric sensors**
 - III.2.2. Piezoelectric Effect**
 - III.2.3. Pyroelectric Effect**
 - III.2.4. Electromagnetic induction effect**
 - III.2.5. Hall effect**
 - III.2.6. Photoelectric effect**
- III.3. Passive Sensors:**
 - III.3.1. Resistive Sensors**
 - III.3.1. Capacitive Sensor**
 - III.3.1. Resistive Sensor**
- III.4. Conditioner of a sensor.**

CHAPTER IV: THERMOMETERS

- IV.1. Dilation Thermometer:**
 - IV.1.1. Description**
 - IV.1.2. Law of variation**
 - IV.1.3. thermometric liquid**
- IV.2. Gas Expansion Thermometer**
 - IV.2.1. Principle**
 - IV.2.2. Description**
- IV.3. Solid Expansion Thermometer**
 - IV.3.1. Principle**

IV.3.2. the Bilame

IV.4. Electric Thermometers:

IV.4.1. Resistance Thermometers

IV.4.2. Thermistors

IV.5. Thermocouples; Peltier effect, Thomson effect, Seebeck effect

Instrumentation II

Chapter I: Theoretical and practical aspects of chromatography

I.1. General

I.1.1. General presentation of chromatographic techniques

I.1.2. Objectives and areas of application

I.1.3. Overview of the Global Chromatography Instruments Market

I.2. Influence of parameters linked to instrument settings on the quality of chromatographic analysis

I.2.1. Analog description of the chromatographic phenomenon and importance of mastering the selectivity and efficiency criteria

I.2.2. Impact of experimental conditions on the quality of chromatographic analysis

has. Sample introduction techniques

b. Column length

vs. Nature and characteristics of the stationary phase

d. Mobile phase speed

Chapter II: Gas chromatography

II.1. General presentation of the equipment

II.2. Different organs of a gas - phase chromatograph

II.3. Food e n g a z

II.3.1 . Types of gas

II.3.2. Identification of contaminants

II.3.3. Gas purification systems

II.3.4. Maintenance (leak detection, flow measurement)

II.4. The automatic sample changer, injection syringe and vials

II.4.1. Choice of syringe

II.4.2. Sampling bottles (vials) and septa

II.5. The injector

II.5.1. Split injection

has. Principle of operation

b. Procedures and practical rules for split injection

II.5.2. Splitless injection

has. Principle of operation

b. Procedures and practical rules for splitless injection

II.5.3. Choice of insert

II.6. The column

II.6.1. Different types of columns and selection criteria

II.6.2. Comparison between packed and capillary columns

- II.6.3.** Criteria for the selection of stationary phases and dimensions of appropriate columns
 - has.** Polysiloxanes
 - b.** Polyethylene glycols (PEGs)
 - vs.** Chiral stationary phase
- II.6.4.** Procedure for installing capillary columns
 - has.** Use of ferrules
 - b.** Use of guard columns
- II.7.** The detector
 - II.7.1.** General presentation
 - II.7.2.** Classification of detectors
 - has.** Concentration-dependent detectors vs. Detectors dependent on the mass flow of solutes
 - b.** Universal detectors vs. selective or specific detectors
 - vs.** Destructive detectors vs. Non-destructive detectors.
 - II.7.3.** Detector characteristics
 - has.** Detection limit
 - b.** Linearity domain
 - vs.** Dynamic range
 - II.7.4.** Different types of detectors
 - d.** Universal FID and TCD detectors: Operating principle, characteristics and maintenance
 - e.** Selective NPD, ECD and FPD detectors: Operating principle, characteristics and maintenance

Chapter III: Liquid chromatography

- III.1.** General
 - III.1.1.** Separation techniques: Which technique for which compounds?
 - III.1.2.** Comparison of LC with GC
 - III.1.3.** History of HPLC
 - III.1.4.** Examples of different HPLC instrument configurations
- III.2.** The different modules of an HPLC chain and their principles of functioning
- III.3.** The pump
 - III.3.1.** Isocratic pump
 - III.3.2.** Gradient pumps
 - has.** Binary pumps
 - b.** Principle of operation of a pump with two heads in series
 - vs.** Quaternary pumps
 - III.3.3.** Comparison between isocratic and gradient modes
- III.4.** The injector
 - III.4.1.** Manual injector
 - III.4.2.** Autosampler
- III.5.** Column and mobile phase
 - III.5.1.** Influence of the nature of the stationary phase

- a. Silica gel, basic material for current phases
 - b. Grafted silicas
 - c. Influence of particle size
- III.5.2. Influence of the composition of the mobile phases on the eluting power and on the viscosity
- III.5.3. Importance of temperature control
- III.6. The detector
 - III.6.1. Spectroscopic detection - Ultraviolet (UV) absorption
 - a. Operating principle and impact of experimental conditions on its effectiveness
 - b. Comparison between the simple UV detector and the array detector diode (DAD)
 - III.6.1. Refractive index detector
 - III.6.1. Fluorescence detector
- III.7. Current Trends in HPLC
 - III.7.1. Constraints imposed by coupling with mass spectrometry
 - III.7.2. Evolution of HPLC towards UPLC

Chapter IV: Mass spectrometry

- IV.1. Introduction
- IV.2. Ionization sources
 - IV.2.1 Conventional “direct” ionization methods
 - has. Electronic ionization
 - b. Chemical ionization
 - IV.2.2. So-called “soft” or “indirect” ionization methods:
 - ion desorption/desolvation
 - has. Electrospray Ionization, ESI
 - b. Atmospheric pressure chemical ionization (APCI)
- IV.3. Analyzers
 - IV.3.1. Acceleration and focus
 - IV.3.2. Electromagnetic analyzer
 - IV.3.3. Time-of-flight (TOF) analyzer
 - IV.3.4. Quadrupole analyzer
 - IV.3.5. Ion trap
- IV.4. Detector
 - IV.4.1. The electron multiplier
 - IV.4.2. The microchannel plate
 - IV.4.3. The photon multiplier
- IV.5. Tandem mass spectrometry

Metrology

Chapter 1: Introduction to metrology

- I.1. General**
- I.2. Definitions**
- I.3. Example of Metrology**
- I.4. Why announce uncertainty ?**
- I.5. The causes of errors in the process measures**
- I.6. General properties of instruments measure**
- I.7. Measurements and errors experimental**
- I.8. Uncertainty in a measurement: e**
- I.9. Assessment**

Chapter 2: General information on sensors/or the acquisition of a greatness

Physical

II.1. Introduction

II.2. Definitions

- II.2.1. THE sensor**
- II.2.2. Scope of measure**
- II.2.3. There resolution**
- II.2.4. There sensitivity**
- II.2.5. There precision**
- II.2.6. There speed**

II.3. Classic types error

- II.3.1. The error of zero**
- II.3.2. The mistake scale**
- II.3.3. The mistake hysteresis**
- II.3.4. The error of quantification**

II.4. The system of units international

II.5. Links between SI units and other units (USA)

II.6. Composition of a measurement chain computerized

II.7. Classification of signals

- II.7.1. Signal Analog**
- II.7.2. Signal digital**

II.8. Classification of sensors

- II.8.1. Sensors assets**
- II.8.2. Sensors passive**

Chapter 3: Sensors: conditioners associates

III.1. Conditioners associated with sensors assets

- III.1.1. Sensor Source tension
- III.1.2. Source sensor fluent
- III.1.3. Source sensor charge
- III.2. Passive Sensors-conditioners associates
 - III.2.1. Montages potentiometric
 - III.2.2. Assemblies in bridge
 - III.2.3. Montages oscillating

Chapter 4: Sensors Temperature

- VI.1. Introduction
- VI.2. The principle of sensors temperature
 - VI.2.1. Direct sensors: the effect thermoelectric
 - VI.2.2. Sensors indirect

Chapter 5: Sensors humidity

- V.1. Introduction
- V.2. Some reminders of thermodynamics
 - V.2.1. Balance of a body pure
 - V.2.2. Empirical relationships and semi-empirical
 - V.2.3. Results and numerical data relating to the water
 - V.2.4. Gas and steam mixtures water
- V.3. Definitions relating to hygrometry
 - V.3.1. Humidity relative
 - V.3.2. Humidity absolute
 - V.3.3. The report of blend
 - V.3.4. Point of dew
- V.4. Different types hygrometry
 - V.4.1. Introduction
 - V.4.2. Variable humidity hygrometers resistance
 - V.4.3. Capacity hygrometers variable
 - V.4.4. Measuring the point of dew
 - V.4.5. Hygrometers electrolytics
 - V.4.6. Hygrometers mechanical
 - V.4.7. Psychrometers
 - V.4.8. Other types hygrometers

Chapter 6: Measurement and Detection of level

- VI.1. Measurement and detection of level
 - VI.1.1. By application of Hydrostatics
 - VI.1.2. By resistive effect and conductivity
 - VI.1.3. Measure at fmoiteur
 - VI.1.4. Effective measure capacitive

VI.1.5. Effective measure optical

Module: GM2.5 VH: 28 TP

TP Instrumentation and metrology

TP Metrology

Handling No. I: Measuring lengths

Handling No. II: Weighing & Mass Measurement

Manipulation No. III: Density measurement

Handling No. IV: Temperature measurement

Instrumentation TP I

Manipulation No. I: Balance

Handling No. II: Voltmeter ammeter

Handling No. III: Different types of thermometers

Module: GM2.5 VH: 28 TP

Electronics TP

Manipulation No. I: General theorems

Manipulation No. II: Quadrupoles and linear filters

Handling No. III: Diodes and Diode Circuits

Handling No. IV: Bipolar transistor

Manipulation No. V: Field effect transistor

Manipulation No. VI: Operational amplifier

Module: GM2.6 VH: 21 C

Computer science

Chapter 1: Introduction to chemoinformatics

- I.1. Origin and history.
- I.2. Chemical databases.
- I.3. Chemical simulation software.
- I.4. Statistical calculation software.
- I.5. Graph plotting software.

Chapter 2: The MATLAB environment

- II.1. General Introduction.
- II.2. Inputs/outputs
- II.3. Basic instructions.
- II.4. Variable declarations and manipulations.

Chapter 3: Vectors and Matrices in MATLAB

- III.1. Declarations.
- III.2. Basic operations.
- III.3. Display and transformations.
- III.4. Representation 2D and 3D graphics.

Chapter 4: Programming in MATLAB

- IV.1. The usual control structures.
- IV.2. Help instructions.
- IV.3. MATLAB functions.
- IV.4. The M-files.
- IV.5. Function calls.

Chapter 5: Approximations and resolutions of systems

- V.1. Linear interpolation (mathematical foundations and examples of use)
- V.2. Linear regression (mathematical foundations and examples of use).
- V.3. Real-world use cases related to experimental tasks.

Chapter 6: Introduction to Relational Databases

- VI.1. Concept of a Database.
- VI.2. Advantages of storage and queries.
- VI.3. The “Table” data structure.
- VI.4. N-ary relationships.
- VI.5. Relational patterns.
- VI.6. Concept of queries and examples of DBMS.
- VI.7. Creation and population of a Database.
- VI.8. Application examples.

Module: GM2.6 VH: 28 TP

IT practical work

Manipulation No. I :: Introduction to the MATLAB environment, the exploitation of the interface, direct application of course examples on basic data processing instructions.

Manipulation No. II : Vector and matrix calculation.

Manipulation No. III : Tracing, saving and exporting 2D and 3D graphics.

Handling N°IV : Programming in MATLAB and creation of batteries of M-files type functions.

Manipulation No. V : Resolution of a linear interpolation problem.

Handling No. VI : Solving a linear regression problem.

Communication techniques

Chapter I: Communication

- I.1.** Jakobson's diagram
- I.2.** Language functions
- I.3.** Types of communication

Chapter II: Recruitment

- II.1.** Personal and professional assessment
- II.2.** The resume
- II.3.** The motivation letter
- II.4.** The job interview

Chapter III: Oral communication

- III.1.** Non-verbal communication
- III.2.** Intonation and articulation
- III.3.** Speech
- III.4.** Oral description
- III.5.** Oral argument

Chapter IV: The end-of-studies project

- IV.1.** The stages of developing the dissertation
- IV.2.** Bibliographic references
- IV.3.** The oral presentation

Chapter V: Reminders for writing correctly

- V.1.** Grammatical and spelling difficulties.
- V.2.** Faulty constructions: barbarisms and pleonasms

English Curriculum for ICAI4

The First session: A preparation for the TOEIC from TARGET SCORE

Target Score is a course book specifically designed for students who want to improve their overall level in International English and measure their performance. The aim of this course is to prepare students for the TOEIC test (if they need any certification).

The book contains 12 units. Only the first six units are dealt with because of time constraints.

Each unit is well divided and contains the following components

- a- Snapshots
- b- Listening (authentic material and native speakers)
- c- Grammar check
- d- Vocabulary builder
- e- Viewpoint
- f- Communication
- g- TOEIC tips

After each three units, students have to take a mock test of 50 questions.

Unit Focus	Listening	Grammar Check	Vocabulary Builder	Reading	Speaking and Writing
Career professions, recruitment, training	Temporary agency Job interview Job fair talks	Present simple/present continuous WH-questions	Suffixes professions	Indian companies cultural training for companies	Preparing for a job interview
Work places Offices, technology, facilities	Complaints Office descriptions Communication at work	Count/non-count nouns Prepositions of place	Word families: forms	Little brother: surveillance in the workplace	Participating in a discussion
Communications News, Internet, broadcasting	Information Telephoning Radio news bulletin	Items Present simple/present continuous	Compound nouns	Writing it down or talking it up: cultures of communication	Holding a press conference

REVIEW TEST 1 (UNITS 1-3)

Unit Focus	Listening	Grammar Check	Vocabulary Builder	Reading	Speaking and Writing
Retailing Blinds, products, services	Shopping Starting a new business venture Product information	Comparatives and superlatives Tag questions	Separable prefixes	Camper: a company profile	Making a product presentation
Industry Production, construction, automation	Factory tour Industrial problems News report	The passive Causative verbs	Synonyms and antonyms	Robots to the rescue: robots in Japan	Attending a meeting
Trade Markets, shipping, import and export	Art market Coffee costs Meetings	Future forms Cause and effect	Idiomatic expressions: point	Juan Valdez: developing the coffee market	Presenting arguments

REVIEW TEST 2 (UNITS 4-6)

The second session: Oral presentations

The second session is devoted to oral presentations. Students are required to prepare a topic of their choice and present it in class. The aim of this session is to improve their speaking skills. Students learn how to take notes during a presentation, how to evaluate and ask questions.

Chapter I: Why teach the subject Corporate Culture?

Chapter II: The company and its environment

- II.1. The definition of business
- II.2. Stakeholders in the company
- II.3. Business environment

Chapter III: The profile of the Entrepreneur

- III.1. The key characteristics that must be present in an entrepreneur

Chapter IV: Sources of project ideas

(Project feasibility study)

Chapter V: The Business Plan

- V.1. definition and objectives
- V.2. the content of a business plan

Chapter VI: Market study

- VI.1. Definition of market research
- VI.2. The different market research tools

Chapter VII: Strategies and marketing plan

- VII.1. The segmentation
- VII.2. Targeting
- VII.3. The positioning
- VII.4. Marketing Mix (Product policy/Pricing policy Policy communication / Distribution policy)

Chapter VIII: Technical Study

- VIII.1. Resources in buildings and land
- VIII.2. Operating equipment resources
- VIII.3. Means in intangible elements
- VIII.4. Human resources
- VIII.5. Suppliers and subcontractors

Chapter IX: Study of profitability

- IX.1. Determining the initial investment and cash flows
- IX.2. The criteria for evaluating the profitability of projects (NPV, IRR, Ip, break even...)

Chapter X: The financial plan and sources of financing for projects

- X.1. Construction of the initial financing plan
- X.2. Projected income statement
- X.3. The cash flow plan
- X.4. The 3-year financing plan

X.5. Sources of business financing (self-financing, BTS, BFPME, SICAR, FOPRODI, FONAPRAM.....)

Chapter XI: Choice of legal status

X I.1. the different legal forms of businesses

XI.2. The choice of legal status

Third Year IC5

GM & MA	MODULES
GM3.1	Industrial Processes
	Electrochemical Methods of Analysis
	TP Electrochemical Methods of Analysis
GM3.2	Water Analysis and Treatment
	Separation of enantiomers
	Chemistry of Essential Oils
	Agri-Food Biotechnology
GM3.3	Evaluation of the uncertainty of Analysis Methods
	Validation of Analysis Methods
	Chemical Engineering
GM3.4	English
	Health and Safety
	Standards and Quality Control
TOTAL	
Project Graduation	

Industrial Processes

Chapter I: Thermodynamic reminders

- I.1.** Balances between phases
- I.2.** Concept of Chemical Potential and Fugacity
- I.3.** Liquid-vapor equilibrium: Pure bodies and Solutions Applications to distillation
- I.4.** Liquid-Liquid Equilibrium: Applications to liquid-liquid extraction
- I.5.** Liquid-solid equilibrium: Applications to separation methods – Leaching Hydrometallurgy

Chapter II: Kinetic reminders

- II.1.** Classification of chemical reactions and catalytic reactors
- II.2.** Evolution of chemical systems involving several reactions

Chapter III: Classification of Unit Operations

- III.1.** unitary material transfer operations using co-current and countercurrent.
- III.2.** unit heat transfer operations.
- III.3.** unit operations based on mechanical principles
- III.4.** Homogeneous and Heterogeneous reactors - Batch/Flow process

Chapter IV: Oil Refining

- IV.1.** Reminder on the genesis of oil.
- IV.2.** Refining OUs: Desalting- Topping- Cracking and Reforming catalytic
- IV.3.** The different stages of crude oil analysis
- IV.4.** Analytical characteristics of refining products
- IV.5.** Water effluent from a Refinery
- IV.6.** Standards and techniques for analyzing certain discharges Courses + applications on oil refining.

Chapter V: The Paper Industry / Paper

- V.1.** Reminder on the composition of wood – Holo cellulose – Morphology
- V.2.** Where to obtain paper pulp
- V.3.** Mechanical pulp - MP process
- V.4.** Chemical pulp – Kraft process – Bisulphite process
- V.5.** Whitening of paper pulp
- V.6.** Paper manufacturing and classification
- V.7.** Analytical control of paper
- V.8.** Paper conservation processes

Chapter VI: The leather industry

VI.1. General Chemistry of the leather industry

VI.2. Tanning and principle – tannin salts

VI.3. OUs of the leather industry

VI.3.1. The OUs upstream of tanning – Salting – Re-greening Hair removal – Confiting

VI.3.2. Post tanning OUs – corying – Dyeing – drying – Food

VI.4. Garnishing and Pollution

VI.4.1. Analysis of water discharges - Standards and procedures

VI.5. Overview of new “clean” processes for leather tanning.

Chapter VII: Perfume and cosmetic products

VII.1. Definition

VII.2 Raw material

VII.3. Classification

VII.4. Obtaining processes

VII.5. Formulation of Cosmetic Products

VII.6. Analytical techniques.

Chapter VIII: Phosphoric acid

VIII.1. Reminders on phosphates - Composition and mineralogy

VIII.2. Processes for obtaining phosphoric acid

VIII.2. 1. Food acid

VIII.2. 2. Industrial acid

VIII.3. Discharges from a phosphoric acid manufacturing plant

VIII.4. Analytical characteristics of the acid produced

VIII.5. Products derived from the phosphate industry.

Electrochemical Methods of Analysis

Chapter I: Reminder of the basic concepts developed in IC3

- I.1.** Diffusion current and diffusion limit current.
- I.2.** Appearance of potential intensity curves for fast systems and slow systems in stationary diffusion regime.
- I.4.** Limits of the electroactivity domain.

Chapter II: Potentiometric methods.

- II.1.** Reference electrodes and indicator electrodes.
- II.2.** Potentiometric measurements at zero current or imposed on one or two indicator electrodes.
- II.3.** Potentiometric determination of the concentration of an ionic species or molecular.
- II.4.** Selective membrane electrodes. Enzymatic electrode.

Chapter III: One or two amperometric methods indicator electrodes.

- III.1.** Amperometric and potentiometric indicators.

Chapter IV: Electrolysis at controlled potential.

- IV.1.** Electrolysis yield.
- IV.2.** Applications: electrolytic refining of metals.
- IV.3.** Selective separation of metal cations.

Chapter V: Constant current electrolysis.

- IV.1.** Coulometric titrations. Applications.

Chapter VI: Impulse polarographic methods.

- VI.1.** Origin of capacitive current
- VI.2.** Normal pulse polarography.
- VI.2.** Amplitude superimposed pulse polarography.

Chapter VII: Conductimetry and conductometric titrations.

- VII.1.** General theory of conductivity. Applications.

Chapter VIII: Analysis by Anodic and Cathodic Redissolution.

- VIII.1.** Organic and inorganic analytical applications

TP. Electrochemical methods of analysis

Manipulation I: Potentiometer at zero current
Application to the determination of cyanide ions

Manipulation II: oxidation-reduction and complexes Cr(VI) titration of Fe(II) alone and in the presence of H_3PO_4

Handling III: Halide dosages

Manipulation IV: Current potentiometer

Manipulation V: Amperometry at imposed potential

Manipulation VI: Conductimetric titration : acid-base dosage (strong acid, weak and mixtures of strong and weak acids)

Manipulation VII: Conductimetric titration: dosage by complexation and by precipitation

Handling VIII: Dosing of a mixture of metal cations using pulse polarography

Manipulation IX: Anodic redissolution

Water Analysis and Treatment

Part one: Water analysis

Chapter I: General information and reminders

- I.1. Water: the challenge of the century
- I.2. Water resources in Tunisia
- I.3. Use of unconventional resources
- I.4. The case of Tunisia

Chapter II: Chemistry of natural waters

- II.1. Water cycle
- II.2. Water composition
- II.3. Specific concentration units
 - II.3. 1. Analysis table and quality of analysis results
 - II.3. 2. Drinking water quality guidelines and standards
- II.4. Properties of water as a solvent (aqueous solutions)
- II.5. Chemical balances in natural waters
 - II.5.1. Thermodynamic considerations
- II.5.2. Equilibria of complex and ion pair formation
 - II.5.3. Acid-base balance
 - II.5.4 . Solubility equilibrium
 - II.5.5. Material balances and speciation
- II.6. Main water analysis methods

Chapter III: Specific titles to water treatment

- III-1 Salinity (conductivity, dry residue,)
- III-2 Hydrotimetric titer or hardness: TH
- III-3 Alkalimetric titers: TA and TAC
- III-4 Turbidity
- III-5 BOD, COD and oxidizability

Chapter IV: Calco-carbonic balances

- IV.1. Presentation of the aggressive and scaling nature of water
- IV.2. Home plate test
- IV.3. The different saturation indices
- IV.4. The different graphic representations of balances calc-carbonic
- IV.5. The representation of Legrand and Poirier

PART TWO: WATER TREATMENT

Chapter I: Treatment sectors

- I.1. Introduction**
- I.2. Drinking Water treatment**
- I.3. General treatments**

Chapter II: Application of ion exchange resins

- II.1. Softening**
- II.2. decarbonation**
- II.3. Demineralization**

Chapter III: Softening by chemical precipitation

- III.1. Softening with lime**
- III.2. Softening by lime and soda**

Chapter IV: Disinfection

Chapter V: Elimination of Iron and Manganese

Chapter VI: Membrane processes

- VI-1 Ultrafiltration and nanofiltration**
- VI-2 Reverse osmosis**
- VI-3 Electrodialysis**
- VI-4 Application to water desalination.**

Enantiomer Separation Methods

Prerequisites

- Basic stereochemistry
- Basic organic synthesis
- Basics of kinetics and thermodynamics
- Chromatography Basics
- Binary diagrams

Chapter I: Introduction

I.1. Why the separation of enantiomers?

Chapter II: Stereochemical concept

II.1. Chirality and symmetry

II.2. Prochirality

II.3. Chirality elements

Chapter III: Splitting of a racemic mixture

III.1. By crystallization

III.1.1. Simultaneous crystallization

III.1.2. Crystallization by entrainment

III.2. By formation then separation of diastereoisomers

III.2.1. Diastereoisomers with covalent bonds

III.2.1. Diastereoisomers with non-covalent bonds

has. Diastereomeric salts

b. Diastereoisomeric complexes

vs. Labile diastereoisomers: Chromatographic methods

c.1. Adsorption

c.2. Inclusion (cyclodextrins, crown ethers, etc.)

c.3. Ligand exchange

c.4. Molecular fingerprint

III.3. By kinetic splitting (chemical and enzymatic)

III.3.1. Classic

III.3.2. Dynamic

Chapter I: Introduction to aromatic and medicinal plants (PAM)

- I.1.** History of PAMs
- I.2.** Definitions: PAM, HE
- I.3.** Geographical distribution of PAMs
- I.4.** HE production units in Tunisia
- I.5.** Research activities on AMPs in Tunisia

Chapter II: EO extraction processes

- II.1.** Definition of an HE
- II.2.** Extraction Methods
- II.3.** Conservation of EOs
- II.4.** Role of HE in PAMs
- II.5.** Name of extraction products

Chapter III: Analysis of the chemical composition of EOs

- III.1.** Physico-chemical properties of EOs
- III.2.** HE analysis techniques (GC-MS)
- III.3.** Main components of EOs, chemotype
- III.4.** Terpene compounds
- III.5.** Variability of the chemical composition of EOs
- III.6.** Applications: case of marjoram and three varieties of thyme

Chapter IV: Varied applications of HE

- IV.1.** Food industry: synthesis of flavors, natural antioxidants and industrial
- IV.2.** Perfume industry: synthesis of fragrances
- IV.3.** Biological activities: anti-inflammatories, antibiotics, antimycotics
- IV.4.** Valorization of EOs from cloves and thyme

The agri-food sector (sectors), bioresources and biotechnologies (Tools).

Chapter I: Food composition and safety and properties required.

- I.1.** Factors controlling contamination and
- I.1.** Multiplication of microorganisms
- I.1.** Reminders of groups of microorganisms.

Chapter II: Contamination

- II.1.** food spoilage by microorganisms (salmonella, clostridia staphylococci, streptococci, molds mycotoxins...).
- II.2.** Growth kinetics of microorganisms and determination of spoilage time and estimation of shelf life of foods

Chapter III: Microbiological analyzes of foods and basis of standards

- III.1.** microbiological reference values.
- III.2.** Collective food poisoning infections TIAC (study of cases and diagnostic steps)

Chapter IV: The different tools and means available for controlling food quality and safety

- IV.1.** the ISO22000 HACCP system, based on hazard analysis, and the application of GHP.
- IV.2.** Understanding of fermentation processes (Microbiology industrial) and illustrations by the manufacture of fermented foods and others.... Selection, production and use of ferments commercial. Control of fermentations through analyzes microbiological, physicochemical and sensory.

Evaluation of measurement uncertainty

Chapter I: General terminology for assessing data uncertainties analytical measurements

- I.1.** Terminology and definition
- I.2.** Measurement errors
- I.3.** Error classification
- I.4.** Sources of uncertainty
- I.5.** Law of propagation of measurement uncertainty

Chapter II: General methodology for estimating uncertainties

- II.1.** Define the measurand
- II.2.** Description of the measurement process
- II.3.** Identification of sources of uncertainty: 5M diagram
- II.4.** Quantifying sources of uncertainty
- II.5.** Calculation of compound standard uncertainty
- II.6.** Calculation of expanded uncertainty

Chapter III: Calibration of scales

- III.1.** Generality and definition
- III.2.** Determining the class of a balance
- III.3.** Determination of standard mass classes
- III.4.** Calibration
- III.5.** Factors influencing the weighing instrument during its calibration.

Validation of analysis methods

Chapter I: verification tests of experimental data

- I.1.** Basics of statistical testing
- I.2.** shapiro-wilk test
- I.3.** dixon test
- I.4.** Single and double grubbs test
- I.5.** Graphical test for rejecting outliers based on Henry's line
- I.6.** Cochran test

Chapter II: evaluation of the reliability of an analysis method

- II.1.** Generalities and normative definitions
- II.2.** Confidence interval of the mean
- II.3.** Concept of repeatability and reproducibility limits
- II.4.** Internal reproducibility
- II.5.** Horwitz's empirical formula

Chapter III: evaluation of the accuracy of an analysis method

- III.1.** Introduction
- III.2.** Accuracy assessment using a certified reference material
- III.3.** Evaluation of accuracy using a reference material
- III.4.** Assessment of accuracy using the laboratory
- III.5.** Evaluation of reliability and accuracy in relation to a method of reference on a sample
- III.6.** Evaluation of reliability and accuracy in relation to a method of reference on several samples

Chapter IV: evaluation of the performance of a calibration curve

- IV.1.** The calibration curve
- IV.2.** Linear model fit test
- IV.3.** Determination of limits of detection and quantification

Chapter v: evaluation of the specificity of an analysis method

- V.1.** Objective
- V.2.** Choice of number of samples and repetitions
- V.3.** Assessment of specificity
- V.4.** Metered addition method

Chapter VI: evaluation of the robustness of an analysis method

- VI.1.** Introduction

- VI.2.** Principle of robustness testing
- VI.3.** The experimental plan
- VI.4.** Identification and selection of factors
- VI.5.** The two-level full factorial designs
- VI.6.** Mathematical model
- VI.7.** Carrying out the significance test of the effects

Chemical Engineering

Reminders on material balances without and with chemical reaction

Chapter I: Distillation

- I.1.** General
- I.2.** Liquid-vapor equilibrium
- I.3.** Simple distillation
- I.4.** Flash distillation
- I.5.** Distillation with Reflux
- I.6.** Thermal balance and material balance - calculation of theoretical plates
HUT-NUT
- I.7.** Application to oil refining and perfume production - calculation
of a distillation column
- I.8.** Applications to distillation processes.

Chapter II: Liquid-liquid extraction

- II.1.** General
- II.2.** Material balance
- II.3.** Extraction processes
- II.4.** Applications on extraction processes

Chapter III: Crystallization

- III.1.** General
- III.2.** Crystallization theory
 - III.2.1.** Evaporation crystallization
 - III.2.1.** Crystallization by cooling
- III.2.** Liquid-solid equilibrium
- III.3.** Thermal balance and material balance
- III.4.** Analytical techniques for controlling crystallization products:
application to the crystallization of slightly soluble salts
- III.5.** Applications on crystallization processes

Chapter IV: Filtration

- IV.1.** General
- IV.2.** Filtration theory
- IV.3.** Choice of filters
- IV.4.** Equipment
- IV.5.** Filtration applications

Chapter V: Chemical reactors

- V.1.** Classification of chemical reactors –Homogeneous/heterogeneous

- V.2.** Cascade reactors
- V.3.** Optimal conditions
- V.4.** Volume calculation
- V.5.** Terminology and symbols
- V.6.** Applications on ideal stirred reactors and tubular reactors

Chapter VI: Fluidization – Drying

- VI.1.** Definitions and generalities
- VI.2.** Heat transfer and mass transfer
- VI.3.** Fluidization techniques
- VI.4.** Drying modes
- VI.5.** Drying kinetics
- VI.6.** Freeze-drying: balance sheet calculation
- VI.7.** Drying applications

English Curriculum

The first part: Reading and Writing

The first part focuses on reading and writing. Students are required to read guidelines on how to write good letters of applications, letters of internships, CVs... Thereafter, they are asked to write their own CV and their own letter of application responding to a job advertisement.

Students are also trained to read scientific articles, scientific papers, and scientific reports. They are required to write a lab report about a chosen experiment.

The second part: Listening and Speaking (Oral presentations)

The second session is devoted to oral presentations. Students are required to prepare a topic of their choice and present it in class. The aim of this session is to improve their speaking skills. Students learn how to take notes during a presentation, how to evaluate and ask questions.

Health and Safety in chemistry laboratories

General Introduction

Management of chemical risk in the workplace in Tunisia

Chapter I: Fire – explosion risks

Chapter II: Chemical risks

Chapter III: Electrical risks

Chapter IV: Radiation Risks

Quality Control Standard

Chapter I: Concepts and terminology

- I.1.** The ISO 17000 standard (2004): assessment of conformity-vocabulary and general principle
- I.2.** The ISO 9000 (2000) standard: quality management system-principles essentials and vocabulary

Chapter II: management requirements

- II.1.** Presentation of the ISO / IEC 17025 (2005) standard
- II.1.** Scope and objectives
- II.1.** Management requirements
- II.1.** Technical requirements

Chapter III: technical requirements

- II.1.** Staff
- II.1.** Facilities and ambient conditions
- II.1.** Test method, calibration and method validation
- II.1.** Equipment

Final Year Project (FYP)

Program: Analytical Chemistry and Instrumentation

Semester: 6th Semester (S6)

Credits: 15 ECTS

1- Objectives

The Final Year Project (FYP) is a capstone component of the program, aiming to:

Apply theoretical and practical knowledge acquired throughout the academic curriculum.

Address a real-world problem in a professional or academic setting.

Develop critical thinking, scientific communication, and project management skills.

Facilitate students' integration into the professional environment and improve employability.

2- Content and Structure

The project is typically conducted within a company, research lab, or academic institution, and includes:

Orientation and integration within the host organization.

Problem definition and project planning.

Literature review and state-of-the-art analysis.

Experimental, theoretical, or technical work.

Scientific report writing.

Oral defense before an academic jury.

Skills Developed

Technical: Use of analytical instruments, experimental design, data analysis.

Transversal: Autonomy, teamwork, scientific writing, communication, time management.

Professional: Adaptation to workplace environments, ethics, safety protocols.

Supervision

Each student is supervised by:

An **academic supervisor** from the Faculty

A **professional supervisor** from the host institution or company.

Evaluation Criteria

The final grade is based on the following components:

Company supervisor evaluation (60%), based on:

Work capacity, autonomy, responsibility, punctuality.

Teamwork, compliance with internal regulations.

Technical and analytical skills, quality of work, maturity.

Written report evaluation by academic jury (20%)

Oral defense evaluation by academic jury (20%)

Indicative Timeline

January – February: Search for internship, signature of internship agreement.

March – May: Internship period and project execution.

June: Report writing and oral defense.

Deliverables

Signed internship agreement.

Evaluation form completed by the company supervisor.

Final written report (both digital and printed versions).

Oral presentation before the jury.

