ULT Chemical Engineering

Subjects Modules for S1

Semester 1 Year 1

U.1.1 Engineering Tools

Applied Mathematics

Module designation	- **Engineering Tools**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.1
Subtitle, if applicable	-
Courses, if applicable	**Applied Mathematics**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr. Khalil ZAGHDOUDI
Lecturer	Phd. Dorra GRAMI
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 42 hours of classroom course/semester
Workload	Total 84 hours/semester (42 hours of Self-Study/semester)
Credit points	3 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Mathematics- Preparatory Cycle
Module objectives/intended learning outcomes	**Objectives:** 1. Introduction to Matrix calculation 2. Solving differential equations 3. Understand Laplace Transform **Learning Outcomes:** Students will be able to : 1. Gain analysis and synthesis skills 2. Solve linear differential equations, measurements' and distributions' 3. Solve linear systems

Content	**Classroom Lecture and Guide Work- Applied Mathematics** **Chapter 1 :**General introduction **Chapter 2 :** Z-transforms **Chapter 3:**Complex integration **Chapter 4 :** Fourrier transforms **Chapter 5 :** Boudary value problems **Chapter 6:**Linear system **Chapter 7:** Matrix calculation **Chapter 8:**Solving 1st and 2nd order differential equations **Chapter 9:**Laplace Decomposition and Transformation **Chapter 10:**Solving Convexity and Optimization Problems
Study and examination requirements and forms of examination	Format: Written Mid-term Exam (40%) + Final Exam (60%)
Media employed	Course Material (Hard/ Soft copy) for classroom& Online (Moodle ULT) Video projection
Reading list	-Demengel, G.: Transformation de Laplace, Théorie et illustration par les exemples. Ellipses, 2002. -Boccara, N.: Distributions. Mathématiques pour l'ingénieur, Ellipses, 1997. -CBSE 12 Math Survival Guide-Differential Equations. Subhashish Chattopadhyay. (2016). CBSE Standard.

U.1.1 Engineering Tools

Applied Statistics

Module designation	- **Engineering Tools**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.1
Subtitle, if applicable	-
Courses, if applicable	- **Applied Statistics**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil Zaghdoudi
Lecturer	Phd. Oussama SOUAI
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 21 hours of classroom course/ semester
Workload	Total 51 hours/semester (30 hours of Self-Study/semester)
Credit points	2 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Numerical Analysis Linear algebra Multivariable functions
Module objectives/intended learning outcomes	**Objectives:** 1. Introduction of statistics fields of application 2. Understand the technique of programming with R 3. Introduction to Statistics & Probability theory **Learning Outcomes:** Students will be able to : 1. Learn the main techniquesof unvaried and bivariate statistics 2. Implement these techniques appropriately 3. Calculate the probability of random events in daily or professional context.

Content	**Classroom Lecture and Guide Work- Applied Statistics** **Chapter 1 Introduction:** - Definition and fields of application of statistics - The statistical approach - Objectives and lesson plan **Chapter 2 Programming with R:** - Introduction - Basic commands (Objects, Arithmetic operations ...) o Vectors o Matrices, tables and Lists o Conversions - Arithmetic operations - Functions - Graph (Histogram, Boxplot ...) **Chapter 3 Descriptive statistics :** - Variability, precision, accuracy - Population and sample - Reasons for sampling - Describe a sample - Classify data - Example of frequency table and associated histograms - Measures of central tendency - Dispersion measurements - *Application exercises* **Chapter 4 Probability:** - Convention: events - Contrary events - Intersection, Union and intersections - Compatibility - Addiction - Conditional probabilities - Law of total probabilities - Law of conditional probabilities - Hybrid formula - *Applications* **Projects : (14 hours of Self Study hours/semester)** Students are divided into groups of 4 students. A project will be assigned tostudents group early in the semester. The students will be asked to develop a project plan and will work on project throughout the course. Students groups will work on a given project from the list below **Project Topics:** **Proposal 1:** Study of Corona-virus statistics in tunisia during the laste 2 years using R.

	Proposal 2: Modelization of Statistical analysis of corona virus data collected in north Africa. **Proposal 3:** Set up a platform capable of predicting the most probable diseases from the symptoms.
Study and examination requirements and forms of examination	Format: Project oral presentation (30%)+ Practical Exam (70%)
Media employed	Course Material (Hard/ Soft copy) for Laboratory& Online (Moodle ULT) Practical programming in Computer Lab (R Software) Video projection
Reading list	-Probabilités, (Mathématiques pour l'informatique) François BRODEAU et Guy ROMIER, édition Armand Colin. -Probabilités pour Scientifiques et ingénieurs, Patrick BOGAERT, édition de Boeck.

U.1.1 Engineering Tools

Applied computing I

Module designation	- **Engineering Tools**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.1
Subtitle, if applicable	-
Courses, if applicable	- **Applied computing I**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil Zaghdoudi
Lecturer	Dr. Khalil ZAGHDOUDI
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	21 hours of practical workshop (Computing Laboratory),
Workload	Total 51 hours/semester (30 hours of Self-Study/semester)
Credit points	2 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Numerical Analysis, Matrix and linear algebra
Module objectives/intended learning outcomes	**Objectives:** 1. Introduction to Excel programming (data entry, interfaces, graphics, etc.) 2. Familiarization using exercises 3. Students will gain a broad perspective about the uses of computers in engineering. 4. Develops basic understanding of the concept of algorithm and algorithmic thinking. 5. Develops the ability to analyze a problem, develop an algorithm to solve it **Learning Outcomes:** Students will be able to : 1. Knox the main features of Excel 2. Perform calculations and use excel functions 3. Know how to handle simple and dynamic tables, graphs and forms. 4. To solve problems responding to a specification using Visual Basic programming based on several examples from practical calculation cases 5. To translate a calculation problem in Excel.

Content	**Classroom Lecture and Guide Work-Applied computing I.** Chapter I : Using Excel 1. Introduction to Excel 1.1. Using the Excel interface 1.2. Using built-in functions in Excel 1.3. Creation of Simple Tables & Pivot Tables 1.4. Plotting graphics 1.5. Pivotal cross charts 1.6. Creation of lists 1.7. Creation of forms **Chapter II: Creation of Macros** 1. The Macro Recorder 1.1 How to create and save a Macro 1.2 How to run a Macro **Chapter III: Visual Basic Environment** 1. Visual Basic VBA 1.1 Project explorer 1.2 Code modules 1.3 Procedures 1.4 How to modify a Macro + macro operations 1.5 Modules (export, import, delete, etc.) 2. Basic rules 2.1 Instructions by line 2.2 Upper and lower case 2.3 Comments, empty lines, spaces, indents 3. Excel Object module 3.1 Objects 3.2 The collections 3.3 The path to objects **Chapter IV: Defined Functions** 1. Creating a function 1.1 Create a function 1.2 Use an Excel built-in function 2. VBA language 2.1 Variables 2.2 Constants 2.3 Types of variables 2.4 Declaration of variables and constants 2.5 Conditions on the variables **Chapter V: Input & output functions** 1. MsgBox 2. InputBox **Chapter VI: Conditional statements** 1. The If Condition Statement 2. Multiple Select Case Connection

	Chapter VII: Iterative statements 1. For Loop 2. Do While Loop… ..Loop 3. Do Loop… ..While 4. Do Loop… ..While **Projects : (14 hours of Self Study hours/ Semester)** Students are divided into groups of 4 . A project will be assigned to students group early in the semester. The students will be asked to develop a project plan and will work on project throughout the course. Students groups will work on a given project from the list below **Project topics:** **Proposal 1:** Equipment laboratory management: qualification of given equipmentwith excel sheet using Measurement errors / uncertainties experimental data. **Proposal 2:** Creation of the equipment file for laboratory equipment using cross charts and forms. **Proposal 3**: Calculate activation energie Ea using experiental kinetics data of olive oil oxydation from rancimat analysis. **Proposal 4**: Optimisation of VBA Macros for the calculs of a Balance Refrigeration of a cold room for vegetables and fruits. **Proposal 5**: Programming a VBA application sheet for equipemnt validation & qualification tools. **Proposal 6**: Design of a VBA program for solving differential equations with the Euler method. **Proposal 7**: Design of a VBA program which has the function of managing copyright invoices and updating a word table.
Study and examination requirements and forms of examination	Format: Project oral presentation (30%)+ Practical Exam (70%)
Media employed	Course Material (Hard/ Soft copy) for Laboratory& Online (Moodle ULT) Practical programming in Computer Lab Video projection
Reading list	Books and hand-outs, websites, Microsoft support (https://support.microsoft.com)

U.1.2 Fundamental Sciences

Physical chemistry

Module designation	**Fundamental Sciences**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.2
Subtitle, if applicable	-
Courses, if applicable	**Physical chemistry**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr. Khalil ZAGHDOUDI
Lecturer	Phd. Mohamed MEZNI
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 36 hours of contact hours/ semester 6 hours practical workshop/ Semester
Workload	Total 84 hours/semester (42 hours of Self-Study/semester)
Credit points	3 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	-Basics of chemistry, volumic Mass, Molar concentration, states of matter. Basics of the atomic model,

Module objectives/intended learning outcomes	**Objectives:** 1. Predict the physico-chemical properties of elements based on their electronic structure, 2. Compare the different types of intramolecular and intermolecular interactions in the 3 states of matter, 3. Determine the composition at equilibrium of a complex ionic medium, possible site of acid-base reactions, complexation, precipitation or oxidation-reduction. 4. Understand matter in chemistry 5. Understand chemical reaction principle and equilibrium 6. Practice Measurement Precisions & Errors in Laboratory 7. Provide basic knowledge about ionic, covalentand metallic bonding and explains that chemical bonding is best regarded as a continuum between the three cases. **Learning Outcomes:** Studentswill be able to : 1- Calculate the heat balances of a chemical process, 2- Predict the direction of a given chemical reaction 3- Determine the conditions on pressure and temperature under which a chemical transformation is possible 4- Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, andperiodicity in atomicradii, ionicradii, ionization energy and electron affinity of elements. 5- Draw the plausible structuresand geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomicmolecules). 6- Understand and explain the differential behavior of organic compounds based on fundamental conceptslearn. 7- Analyze the feasibility of the separation of metal cations in a multi-constituent medium by associating the most appropriate method. 8- Différentier les structures cristallines et leurs propriétés associées,

Content	**Classroom Lecture and Guide Work** 1- Atomic & Molecular structure 1.1 Atomic Models & electronic structure 1.2 The elements (Periodic table) 2 Mass in Chemistry 3- The chemical bonding theory 4- The nature of bonding in chemical compounds 5- States of matter 5.1 Changes of state 5.2Crystal structures: characterization and associated properties 6- Phase equilibria 6.1 Electrolyte and solvation effect - Definition of useful characteristic variables and thermodynamic constants 6.2 Acid-base phenomena (general methodology for calculating a pH - dosage - buffer effect) 6.3 Complexation (characterization of simple and successive complexes - influence of pH on the stability of complexes) 6.4 Precipitation reactions 6.5 Oxido-reduction reactions (redox couple and standard potential - types of electrodes - stabilization of a degree of oxidation by complexation or precipitation - potential-pH diagram). 7- The phase balance diagrams 8- Reactions to equilibrium 9- Physico-chemistry of interfaces 9.1 Interactions at liquid/gas, liquid/liquid, solid/liquid and solid/gas interfaces 9.2 Definition of interfacial tension 9.3 Surfactants in solution, introduction to the notion of formulation (example of dispersed systems and applications) 10. Electrochemistry 10.1 Thermodynamics of electrochemical systems-electrochemical cells, 10.2 Determination of electrode potentials, types of electrochemical cells, 10.3 Activity and activity coefficients, 10.4 theory of dissociation of electrolytes, 10.5 Ionic equlibria **6 hours of Practical Workshop – Physical Chemistry-** **1**. Measurement Precisions & Errors Objectives : - Determine the most suitable sampling instrument for a precise Measurement. **2.** Redox Titration: Analysis of hypochlorite ClO- ion incommercial bleach Objectives : In this experiment, we propose to determine the quantity of hypochlorite ions (ClO-) contained in a bleach by monitoring the Decolourization of the iodine.
Study and examination requirements and forms of examination	Written Mid-term Exam (25%) + Practical Exam (25%)+ Written Final Exam (50%)

Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Practical workshop in Lab Video projection
Reading list	A Textbook of Physical Chemistry – Volume 1 / Mandeep Dalal (First Edition). 9788193872017 (ISBN-13), 8193872010 (ISBN-10). 2018. General Chemistry: The Essential Concepts, 2013, R. Chang & K.Goldsby. Science et génie des matériaux, William D Callister Jr, Dunod, ISBN 2-89 1 13-687-X L'indispensable en état solide, éditions Bréal,ISBN 978-2-7495-0076-8 Chimie inorganique : Shriver- Atkins, DeBoeck Université, ou Casalot-Durupthy, Hachette.

U.1.2 Fundamental Sciences

Thermodynamics

Module designation	**Fundamental Sciences**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.2
Subtitle, if applicable	-
Courses, if applicable	Thermodynamics
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil ZAGHDOUDI
Lecture	Dr Khalil ZAGHDOUDI
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 39 hours of classroom course/semester 3 hours practical workshop/ Semester
Workload	Total 63 hours/semester (21 hours of Self-Study/semester)
Credit points	2.5 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Chemical reaction, endothermic/exothermic reaction, thermodynamics stats variables, mathematics, ideal gas law

Module objectives/intended learning outcomes	**Objectives:** 1. Understand mass, energy, heat, work, efficiency, ideal and real thermodynamic cycles and processes. 2. Understand first and second laws of thermodynamics, perfect gas law, properties of real gases, and the general energy equation for closed and open systems. 3. introduce students to the principles, quantities and tools of thermodynamics essential to process engineering 4. show their use and applications in the energy balances of systems, in the prediction of stable states of matter, in the prediction of the spontaneous evolution of systems, in the dimensioning of simple energy installations **Learning Outcomes:** Students will be able to : 1. Analyze a thermodynamic problem and pose the equations to solve it 2. Solve problems involving matter, energy (1st principle) and entropy (second principle) balances in closed and open systems, in steady and transient states. 3. Estimate or calculate the physico-chemical and thermodynamic properties of pure substances and their variations using the ideal gas model, usual equations of state, and the method of corresponding states, state diagrams or adequate correlations. 4. Analyse basic thermodynamic cycles. 5. Solve problems in chemical reaction

Content	**Chapter I: Thermodynamics** I. General and definition (Reminder on the transformations of a system) II. System and external environment III. Thermodynamic quantities: state quantities IV. Status variable, status function V. First principle of thermodynamics 1- Statement 2- Expression of work exchanged 3- Expression of heat exchanged 4- Expression of variations in internal energy U and enthalpy H 5- Case of ideal gases **Chapter II: Application of the first principle on chemical reactions** I. General introduction II. Variation of internal energy and enthalpy in chemical reactions III. Relationship between ΔU and ΔH IV. Enthalpy of reaction, enthalpy of formation V. Indirect determination of the quantity of heat of a reaction VI. Standard enthalpy of formation of ions in aqueous solutions VII. Binding energy, dissociation energy VIII. Heat variation of reactions with temperature IX. Determination of the heats of reaction at different temperatures **Chapter III: Second principle of thermodynamics, entropy function** I. Introduction II. Statement of the second principle (Principle of evolution) III. Calculation of entropy variation IV. Statistical interpretation of entropy **Chapter IV. Third principle of thermodynamics (Nernst's principle)** 1- Variation of entropy with temperature 2- Variation of entropy during a chemical reaction 3- Determination of the appropriate temperature of a given reaction 4- Notions and examples 5- Free energy and spontaneity in chemical reactions 6- Change in the standard free enthalpy of a chemical reaction. FreeEnthalpy of formation. **Chapter V. Thermodynamicpotential** 1. Equilibrium law, phase rules (Gibbs) 2. Advancement, rate of advancement and selectivity **Chapter VI : MASS, ENERGY AND ENTROPY BALANCE IN OPEN SYSTEMS AND STEADY REGIME APPLICATIONS**

	Practical work-Thermodynamic Chemical thermodynamics (Calorimetry) Objectives : -Measure the values $\Delta_r H^\circ$ of an acid-base reaction in aqueous solution by performing calorimetric experiments. -Check Hess's Law.
Study and examination requirements and forms of examination	Written Mid-term Exam (25%) + Practical Exam (25%)+ Written Final Exam (50%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Practical workshop in Laboratory Video projection
Reading list	-Thermodynamique et équilibres chimiques. Alain Gruger , Collection: Sciences Sup, Dunod 2004 - 2ème édition -Chimie tout-en-un MPSI-PTSI - Cours et exercices corrigés. Bruno Fosset, Jean-Bernard Baudin. Edition: Dunod -Fundamentals of Chemical Engineering Thermodynamics.Kevin D. Dahm & Donald P. Visco Jr. (2015). Cengage learning.ISBN-13: 978-1-111-58070-4. Fundamentals of engineering thermodynamics, 5th edition, Michael, J. MORAN and Howard N. SHAPIRO.

U.1.2Fundamental Sciences

Structural Organic Chemistry

Module designation	**Fundamental Sciences**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.2
Subtitle, if applicable	-
Courses, if applicable	- **Structural Organic Chemistry**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil ZAGHDOUDI
Lecturer	Dr. Yassine MOKADDEM
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 39 hours of classroom course/semester 3 hours practical workshop/ Semester
Workload	Total 63 hours/semester (21 hours of Self-Study/semester)
Credit points	2.5 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	-Basics of the atomic model, Physical Chemistry,

Module objectives/intended learning outcomes	**Objectives:** 1. Predict and explain Patterns and Properties. Predict and explain patterns in shape, structure, bonding, hybridization, formal charge, stability, acidity, basicity, solubility, and reactivity for hydrocarbons, halocarbons, Alkenes, dienes, and arenes, by understanding and applying concepts of organic chemical structure and bonding and stability. 2. Predict reaction products. 3. Aquire structural analysis of organic compounds 4. Recognize the diversity of behaviors (reactions) by the different classes of organic compounds 5. Provide basic notions essential to an understanding of the reactivity of organic compounds **Learning Outcomes:** Students will be able to : 1. Predict the reactivity of organic molecules 2. Be able to recognize, classify, explain, and apply fundamental organic reactions such as SN2, SN1, E2, E1, alkene addition, electrophilic aromatic substitution, 1,2 / 1,4-additions, ring-opening, and radical halogenation. 3. Be able to apply concepts associated with these general reaction types to product prediction, synthesis design, and reaction mechanism. 4. Predict, explain, and rank the relative speeds of different chemical reactions by applying structure-dependent patterns in stability combined with application of mechanism recognition.

Content	**Classroom Lecture and Guide Work** **I. Foundations** 1.Organic Molecules and Chemical Bonding 2. Structure of organic molecules: molecular and structural formula. 3. Structure of functional groups and physical properties of organic compounds: melting and boiling point; solubility. 2.Alkanes and Cycloalkanes 3.Haloalkanes, Alcohols, Ethers, and Amines 4. Stereochemistry (Conformacional Analysis; *Cis-trans* isomerism; Chirality and optical activity) 5. Organic Spectrometry (Introduction to infrared spectroscopy **II. Reactions, Mechanisms, Multiple Bonds** 1. Organic Reactions 2. Reactions of Haloalkanes, Alcohols, and Amines. 3. Nucleophilic Substitution (Duality of mechanism: SN_2 and SN1 reactions; Kinetics, Factors which affect velocity of reactions of SN_2 and SN_1). 4. Alkenes and Alkynes 5. Formation of Alkenes and Alkynes. Elimination Reactions 6.Elimination reactions; Elimination mechanisms: E_2 and E_1; Elimination vs. substitution; Stereochemistry: elimination anti and syn; alkene and alkyne formation 7. Alkenes and Alkynes. Addition Reactions 8.Free Radical Addition and Substitution Reactions **III. Conjugation, Electronic Effects, Carbonyl Groups** 1. Conjugated and Aromatic Molecules 2. Carbonyl Compounds. Ketones, Aldehydes, and Carboxylic Acids 3. Substitute Effects 4. Carbonyl Compounds. Esters, Amides, and Related Molecules **IV. Carbonyl and Pericyclic Reactions and Mechanisms** 1. Carbonyl Compounds. Addition and Substitution Reactions. 2. Oxidation and Reduction Reactions 3. Reactions of Enolate Ions and Enols 4.Cyclization and Pericyclic Reactions **Practical Workshop-Structural Organic Chemistry** Synthesis OF 1,5-DIPHENYLPENTA-1,4-DIENE-3-ONE (Ketolization -Crotonization Reaction) Objectives: Aldolization (also called ketolization in the context of ketones) is an important carbon-carbon bond forming reaction in organic chemistry. It generally involves the nucleophilic addition of an enolate to an aldehyde (or ketone), to form a β-hydroxyketone or aldol (aldehyde + alcohol).
Study and examination requirements and forms of examination	Written Mid-term Exam (25%) + Practical Exam (25%)+ Written Final Exam (50%)

Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Practical workshop in Laboratory Video projection
Reading list	Chimie organique avancée, Carey &Subdberg, DeBoeck Université Eds. - Organic Chemistry second edition, Jonathan Clayden, Nick Greeveset Stuart Warren, Oxford Eds. - Advanced Organic Chemistry, F. A. Carey & R. J. Sunberg, Plenum press 1990. -Transition Metals in the Synthesis of Complex Organic Molecules, L. S. Hegedus and B. C. G. Söderberg, University Science Books 2010.

U.1.3 Transfer & Transport Phenomena

Applied Heat Transfer

Module designation	- **Transfer & Transport Phenomena**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.3
Subtitle, if applicable	
Courses, if applicable	**Applied Heat Transfer**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil ZAGHDOUDI
Lecturer	Dr Mounir Mansour
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 36 hours of classroom course/semester 6 hours practical workshop/ Semester
Workload	Total 84 hours/semester (42 hours of Self-Study/semester)
Credit points	3 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Mathematicstools: coordinate systems for the calculation of volumes and areas. Mathematics operators : Gradient and divergence, LAPLACE transform

Module objectives/intended learning outcomes	**Objectives:** 1. To introduce Basic Principles of Heat Transfer 2. Present Fourier Law and First thermodynamic law 3. To introduce Heat transfer with conduction, convection and radiation with related formula. 4. Steady state and transient problems of Heat Transfer **Learning Outcomes:** Students will be able to : 1. Explain the 3 thermal transfer modes : conduction-convection-radiation 2. Understand the basic concepts and fundamental laws of these 3 transfer modes and know how to apply them in a number of practical numbers 3. To compare the performance of thermal systems.

Content	**Classroom Lecture and Guide Work- Applied Heat Transfer** **Chapter 1: GENERALITIES ON HEAT TRANSFERS** 1. Introduction 2. Definitions 2.1. Temperature field 2.2. Isothermal surface 2.3. Heat flux and density 2.4. Heat flux linked to mass flow 2.5. Thermal insulators 3. Heat transfer modes 4. General equation of balances 5. Electrical analogy **Chapter 2: THERMAL CONDUCTION** 1. FOURIER's law 2. Thermal conductivity 3. General method of dealing with a transfer problem 4. Energy balance equation - Heat equation **Chapter 3: CONDUCTION IN PERMANENT SYSTEM** 1. One-way transfer 2. Multidirectional transfer 3. THE FINS **Chapter 4: VARIABLE DRIVING** 1. unidirectional conduction in variable regime without change of state 2. unidirectional conduction in variable regime with change of state 3. Multidirectional conduction in variable regime **Chapter 5: HEAT TRANSFER BY CONVECTION** 1. Definition 2. NEWTON's law 3. Convection problem 4. Dimensional analysis-VASCHY theorem 5. Convenient method of calculating h 6. Convection without change of state 7. Convection with change of state **Chapter 6: RADIATION HEAT TRANSFER** 1. Definition 2. Nature of radiation 3. Quantities related to radiation 4. Reflection, absorption and transmission 5. Black body 6. Laws of WIEN 7. STEFAN-BOLTZMANN Law

	Chapter 7 : Heat exchager 1. Heat Exchangers Technologies 2. General principle 3.Geometric configurations 4.Tubular exchangers 4.1 Single-pipe exchanger 4.2 Coaxial exchanger 4.3 Core and shell exchangers 4.4 Finned tube heat exchanger 4.5 Plate heat exchanger 5. Heat transfer in simple tube exchangers 6. Heat transfer in complex bundle exchangers **6 hours of Practical Workshop-Applied Heat Transfer** **1.** Sizing of a shell and tube heat exchanger **Objectives :** Calculate the overall energy balance in the shell and tube exchanger using. The calculation of the power transferred by the hot fluid, the heat gained by the cold fluid and the heat losses. Calculate the logarithmic mean temperature and the overall heat transfer coefficient. **2.** Determination of the efficiency of the exchanger: NUT method. **Objectives :** Determine the empirical as well as the theoretical exchange efficiency (using the NUT method), then compare the two. Estimate the different temperatures of the water leaving the exchanger and compare them with the measured values.
Study and examination requirements and forms of examination	Written Mid-term Exam (25%) + Practical Exam (25%)+ Written Final Exam (50%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection Practical workshop in Laboratory Industrial Visit to NATILAIT

Reading list	-Jannot Y., « Transferts thermique », Cours 2ème année, Ecole des Mines Nancy, 2012. -Jean-François Sacadura, « Initiation aux Transferts thermiques », Tec & Doc Lavoisier, 2000. -R. K. Shak and D. P. Sekulic, Fundamentals of Heat Exchanger Design, Wiley, 2015. - Analysis of heat and mass transfer by Eckert and Drake, McGraw-Hill - Fundamentals of heat transfer by Grober, Erk and Grigull, McGraw-Hill - Transport Phenomena. R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot. (2007). Second Edition. ISBN 10-0470115394.

U.1.3 Transfer & transport Phenomena

Metrology

Module designation	- **Transfer & Transport Phenomena**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.3
Subtitle, if applicable	-
Courses, if applicable	- **Metrology**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil ZAGHDOUDI
Lecturer	Phd. Nizar SOMRANI
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 21 hours of classroom course
Workload	Total 51 hours/semester (30 hours of Self-Study semester)
Credit points	2 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Fundamentals of physics. Basic Electronics & mathematics

Module objectives/intended learning outcomes	**Objectives:** 1. To understand the basic principles, construction and working of engineering measurement science. 2. To acquire proficiency in using, calibrating various measurement systems. 3. To understand the problems in measurement system and develop the competency to resolve the problems. 4. To know all the measuring instruments and to measure different parameters in day-today work. 5. To acquire the principles of sensors and actuators and their role in current measurement systems and industrial equipment. **Learning Outcomes:** Students will be able to : 1. Know how to describe the methods of measuring physical quantities and define the concepts related 2. Distinguish between the different types of metrology 3. Have the vocabulary, units, sizes, as well as all the notions related to the measurement science. 4. Make precision & error assessment as well as its evaluation for a measurement. 5. Study of sensor

Content	**Classroom Lecture and Guide Work- Metrology** **Chapter I: Notions of metrology** 1) Introduction 2) Types of metrology a) Scientific metrology b) Legalmetrology c) Industrialmetrology 3) Calibration 4) Verification **Chapter II: International System of Units (SI) and dimensional equations** 1) Introduction 2) Measurement of a quantity with two units 3) Classes of physical quantities 4) International system of units a) Need for an (SI) b) Fundamental units of mechanics c) Derived units 5) Dimensional equations. **Chapter III: Errors and Uncertainties** 1) Introduction 2) Measurement methods 3) Measurement errors / uncertainties 3-1 Inventory of errors on a measurement a) systematic errors b) random errors c) accidental errors 3.2 Significance of errors 4) Calculation of uncertainties due to systematic errors 4 .1 Uncertainty on a direct measurement: a) uncertainties of analog devices (deviation) b) uncertainties of digital devices 4.2 Uncertainty on an indirect measurement 5) Calculation of uncertainties due to random errors 6) Global uncertainty assessment **Chapter IV: Sensors** 1) Measuring chain 2) Definition of a sensor 3) Metrological characteristics **Chapter V: Study of some sensors** 1) Chemical sensors 2) Biological sensors 3) Temperature sensors. **<u>Projects : (14 hours of Self Study hours/Semester)</u>** Students are divided into groups of 4 students. A project will be assigned to students group early in the semester. The students will be asked to develop a project plan and will work on project throughout the course. Students groups will work on a given project from the list below

	<u>Project Topics :</u> **Proposal 1:** Use of sencors for detection of formaldehyde and total carbonyl compounds. **Proposal 2:** Manufacturing methods and characteristics of silicon nanowire chemical sensors. **Proposal 3 :** Sensors for VOC detection **Proposal 4 :** Chemical sensors based on carbon nanotubes
Study and examination requirements and forms of examination	Format: Written Mid-term Exam (40%) + Final Exam (60%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	Techniques de l'Ingénieur, traité Mesures et Contrôle (R 2012) Michel Grout, Instrumentation industrielle, spécification et installation des capteurs et desvannes de régulation, Dunod, ISBN : 2100057316. Pierre-André Paratte et Philippe Robert, Traité d'Electricité, Systèmes de mesure, VolumeXVII, Presses polytechniques et universitaires romandes. ISBN : 2-88074-321-4.

U.1.4Material Sciences

Cristallography

Module designation	**Material Sciences**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.4
Subtitle, if applicable	-
Courses, if applicable	**Cristallography**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil ZAGHDOUDI
Lecturer	Phd. Halim HAMMI
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 21 hours of classroom course/ Semester
Workload	Total 42 hours/semester (21 hours of Self-Study)
Credit points	1.5 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Basics of Inorganic chemistry, Physical Chemistry, Organic chemistry, thermodynamics.

Module objectives/intended learning outcomes	**Objectives :** 1. Acquire knowledge and skills on the structural description and properties, chemical and physics properties of a crystallized solid 2. Apply basic rules of electron orbitals to predict molecular structure and properties. 3. Specify atomic planes, directions, and families of planes and directions within a given crystal structure using Miller indices 4. Use thermodynamics to explain the presence of point defects in crystalline solids. **Learning Outcomes:** Students will be able to : 1. To know to calculate and interpret the energy of network of a solid 2. To know how to distinguish the various types of intrinsic and extrinsic defects in solids. 3. Establish relation between molecular proprieties and the use of materials, 4. Characterize materials and electronic components particularities, 5. Apply basic rules of electron orbitals to predict molecular structure and properties

Content	**Classroom Lecture and Guide Work- Solid Chemistry** **Chapter 1: Energy in ionic solids** I. Introduction II. Expression of reticular energy II.1. Madelung method II.1.1. Born-Lande expression II.1.2. Born-Mayer's expression II.2. Born-Haber cycle **Chapter 2: Covalent solids** I. Introduction II. Diamond carbon II.1. Description of the structure II.2. Crystal pattern II.3. Co-ordination, compactness, density II.4. Diamond properties III. Graphite carbon III.1. Description of the structure III.2. Crystal pattern III.3. Co-ordination, compactness, density III.4. Graphite properties IV. Carbon 60, fullerene **Chapter 3 : Chemistry of transition elements** I. Structures of coordination complexes II. Reactivity of complexes **Chapter 4: Metallic solids** I. Introduction II. Compact stacking II.1. ABA stacking (HC) II.2. ABCA stacking (CFC) III. Semi-compact stack **Chapter 5 :** I. Symmetry of molecules and group structure II. Crystal symmetry
Study and examination requirements and forms of examination	Format : Written Mid-term Exam (40%) + Written Final Exam (60%)
Media employed	Course Material (Hard/ Soft copy) for classroom& Online (Moodle ULT) Practical workshop in Laboratory Video projection
Reading list	- Hachette Livre, H-Prépa Chimie des matériaux inorganiques 2ème année PC - Science et génie des matériaux, William D Callister Jr, Dunod, ISBN 2-89 1 13-687-X L'indispensable en état solide, éditions Bréal,ISBN 978-2-7495-0076-8. -L. E. Smart, E. A. Moore: Solid State Chemistry: An Introduction (4th Ed., CRC Press 2012, ISBN 9781439847909).

U.1.4 Material Sciences

Material Sciences

Module designation	**Material Sciences**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.4
Subtitle, if applicable	-
Courses, if applicable	**material Sciences**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil ZAGHDOUDI
Lecturer	Phd. Malek ATYAOUI
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 42 hours of classroom course/semester
Workload	Total 63 hours/semester (21 hours of Self-Study/semester)
Credit points	2.5 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Physical Chemistry, Solid Chemistry, thermodynamics, Organic chemistry,
Module objectives/intended learning outcomes	**Objectives :** 1. Know the main families of industrial materials and their properties. 2. To provide a direct, rational connection between microscopic understanding and macroscopic properties 3. Understand their advantages and disadvantages from the point of view of their environmental balance. **Learning Outcomes:** Students will be able to : 1. Establish relation between molecular proprieties and the use of materials, 2. Characterize materials and electronic components particularities, 3. Identify the components involved in the design, fabrication and application of materials. 4. Establish the connection between structure and physicochemical properties of polymers; identification of the advantages and disadvantages of these materials in relation to ceramics and metals.

Content	**Classroom Lecture and Guide Work- Introduction to material sciences** **Chapter I: INTRODUCTION TO MATERIAL SCIENCES** **Chapter II : FUNDAMENTALS OF MATERIALS STRUCTURE AND PROPERTIES** 1. *Atomic Structure. Interatomic Bonding in Solids* 2. *The Structure of Crystalline Solids. Foundations of Crystallography* 3. *Diffraction of X-Rays.* 4. *Point Defects. Imperfections in Solids. MicroscopicAnalysis.* 5. *Mechanisms of Diffusion.* **Chapter III: METALS AND METALLIC ALLOYS** 1. *Introduction* 2. *Iron based alloys* 3. *non-ferrous alloy* 4. *MechanicalProperties of Metals.* 5. *Phase Diagrams* **Chapter IV: POLYMERS** 1. *Introduction* 2. *Polymers properties* 3. *Polymerization operation* 4. *Different types of plastics* 5. *Main thermoplastics and their uses* 6. *Main thermosets and their uses* 7. *Biopolymers* **Chapter V: CERAMICS, CEMENT AND CONCRETE** **Chapter VI : SPECIFIC PROPERTIES, CARACTERIZATION, PRODUCTION AND APPLICATIONS** 1. *Metals* 2. *Ceramics* 3. *Composites* 4. *Polymers* 5. *Advanced Materials* 6. *Biomaterial*
Study and examination requirements and forms of examination	Written Mid-term Exam (40%) + Written Final Exam (60%)

Media employed	Course Material (Hard/ Soft copy) for classroom& Online (Moodle ULT) Video projection
Reading list	-Thermodynamique et équilibres chimiques. Alain Gruger, Collection: Sciences Sup, Dunod 2004 - 2ème édition -Chimie tout-en-un MPSI-PTSI. Bruno Fosset, Jean-Bernard Baudin. Edition: Dunod https://ocw.mit.edu/index.htm -Science des matériaux.DUNOD. 3e édition.(2013). ISBN 978-2-10-074559-3.

U.1.5Language and Management

English I

Module designation	**Language and Management**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.5
Subtitle, if applicable	-
Courses, if applicable	- **English I**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil ZAGHDOUDI
Lecturer	Mr. Habib BEN MASAOUD
Language	English
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 21 hours of classroom course/ Semester
Workload	Total 42 hours/semester (21 hours of Self-Study/semester)
Credit points	1.5 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Every student must have a monolingual English dictionary to be used for classroom activities or else an online dictionary downloaded on a smartphone / laptop.
Module objectives/intended learning outcomes	**Objectives:** 1. This course is meant to train students get acquainted with English for Scientific Purposes. 2. Undergraduates are required to master using English adapted to their field of studies. **Learning Outcomes:** Students will be able to : 1. Improve comprehension of scientific texts 2. Enhance their conversational skills in professional contexts

Content	**Unit 1: What is Science :** **1-** Getting started in Research: Having a career in Science …… **2-** Branches of Science…….. **3-** Word Formation: Dictionary use for Scientific Purposes……. **4-** Prefixes & Suffixes for Scientific Use **Unit 2: Introduction to Scientific Vocabulary :** 1- Etymology of words…….. 2- Grammar: Simple Past Vs. Present Perfect…… 3- Materials Science Vs. Materials Engineering……. 4- Selection of Materials……. 5- Oral Skills: Speaking in Public for Scientific Purposes…… **Unit 3 : Matter:** 1- Forms of Energy…… 2- Energy Efficiency…… 3- Work and Power…….. 4- Renewable Energies: Reading Comprehension of Scientific articles + Writing practice **Unit 4: Temperature……:** **1.** Changes of Temperature State……. **2.** Heat Transfer …….. 3. Revision session (Tenses) **Application :** - The student is required to have a printed version or soft copy of the course. - The use of laptops and smartphones is authorized since classroom activities rely mainly on **e-learning**. - Extra-personal use of it is **strictly unaccepted**. - Assignments are delivered ***on a weekly basis*** to the instructor ***by mail*** and are counted as 20 % of the total students' grades. Written tasks are done in class under the assistance of the professor to help students gain confidence in themselves.
Study and examination requirements and forms of examination	Written Mid-term Exam (40%) + Written Final Exam (60%)
Media employed	Course Material (Hard/ Soft copy) for classroom& Online (Moodle ULT) Practicing (oral presentation) Video projection
Reading list	▪ Williams, Ivor. English for Science and Engineering. Professional English Series, 2007. ▪ Donovan Peter. Basic English for Science. English Language Oxford University Press, 2008. ▪ Ibbotson, Mark. Professional English in Use: Engineering. Cambridge University Press, 2009.

U.1.5Language and Management

Communication Techniques

Module designation	**Language and Management**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.5
Subtitle, if applicable	-
Courses, if applicable	- **Communication Techniques**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil ZAGHDOUDI
Lecturer	Phd. Imen BOUDEN SADE
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	21 hours of Seminar/ Projects
Workload	Total 42 hours/semester (21 hours of Self-Study/semester)
Credit points	1.5 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Basic Communication & good French expression

Module objectives/intended learning outcomes	**Objectives:** 1. Help students to distinguish between: the components of communication, the factors that influence communication. 2. Help each learner to define their own skills and their main obstacles in the act of communicating. 3. Prepare learners for successful public speaking. 4. Strengthen the skills and potential of each student and bring them to better value : Elevator Pitch and self- marketing **Learning Outcomes:** Students will be able to : 1. Demonstrate a better understanding of the communication process by identifying, explaining, and applying current communication theories as they relate to a variety of contexts (e.g. interpersonal, intercultural, group, public and professional communication, and mass media). 2. Demonstrate improved interpersonal skills by identifying and developing a repertoire of strategies for improved communication effectiveness and demonstrate the strategies in oral and written contexts. 3. Demonstrate critical thinking by identifying, analyzing, and evaluating the communication behaviors of others and themselves in a variety of contexts (e.g. interpersonal, intercultural, group, public and professional communication, and mass media).

Content	**Seminar/ Group Projects** This teaching consists of putting students in a learning-by-action situation, in order to develop their managerial, leadership, teamwork and communication skills. Students are divided into groups of 3 to 4. They are confronted with real professional and managerial situations, and play different professional roles. Outcomes will be assessed by a series of embedded class assessments and problem-solving exercises, by class assignments, presentations and projects, research assignments and self-analysis in oral and written contexts. **Part A Communication** the factors that influence our communication and the components of communication Exercises: observations and simulations Course: Non-verbal communication Para-verbal communication and verbal communication: practical advice Communication techniques *Practicing Exercises:* Role plays and exercises to develop communication skills **Part B Public speaking** The big talk and the little talk How to make a successful presentation by aligning with international standards *Practicing Exercises:* individual presentation around a concept Elevator Pitch and speed dating **Part C Professional Writing** Writ**e** a professional email and a cover letter *Practicing Exercises*: Correct examples of emails and cover letters
Study and examination requirements and forms of examination	Format: Continuous Control, Oral Presentation Project (100%)
Media employed	Course Material (Hard/ Soft copy) for classroom& Online (Moodle ULT) Practicing (oral presentation) Video projection
Reading list	Books and handouts, websites,

U.1.5Language and Management

Project Management

Module designation	**Languages and Management**
Module level, if applicable	1st year of chemical engineering
Code, if applicable	U.1.5
Subtitle, if applicable	-
Courses, if applicable	- **Project Management**
Semester (s) in which the module is taught	-Semester 1 (S1)
Person responsible for the module	Dr Khalil Zaghdoudi
Lecturer	Phd.Yosra HAMROUNI
Language	French
Relation to curriculum	Professional module (compulsory),
Type of teaching, contact hours	Lecture, 21 hours of classroom course 21 hours of project
Workload	Total 77 hours/semester (35 hours of Self-Study/semester)
Credit points	3 credits
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	No prerequisites Recommended.
Module objectives/intended learning outcomes	**Objectives :** 1. Better fit into professional life, integrate into an organization and a team: exercise of responsibility, team spirit, commitment and leadership, communication with different interlocutors. 2. Understand and act in a complex and organized system. **Learning Outcomes:** Students will be able to : 1. Set time schedule, and come up with estimated cost 2. Describe a project life cycle, and can skilfully map each stage in the cycle 3. Identify the resources needed for each stage, including involved stakeholders, tools and materials 4. Implement managerial and leadership skills.

Content	**Classroom Lecture and Guide Work-Project Management** This module is divided into two section : **1st Section (21 hours of classroom course/ semester)** **General Introduction to project Management** **Chapter I. Concept of project and project management** 1. Definition 2. Objective of a project 3. Project management 4. Project life cycle **Chapter II. Identification of projects** 1. Problem 2. Description of the project 3. Risk assessment 4. Implementation strategy 5. Identification of the environment **Chapter III. Project planning** 1. Tasks assignment 2. Estimated charges 3. Preparation of the Project Schedule 2 nd Session (21 hours of workshop Project/semester) Students are divided into groups of 3 to 4. They are confronted with real professional and managerial situations, and play different professional roles. Students groups will work on a given project during 6 weeks in order to carry on the management of an innovative project. *Tutorials:* Two role-playing / staging sessions will be dedicated to scheduling techniques and project management.
Study and examination requirements and forms of examination	Format: Written Mid-term Exam (40%) + Final Exam (60%)
Media employed	Course Material (Hard/ Soft copy) for classroom & Online (Moodle ULT) Video projection
Reading list	- Project Management. Neha Tickoo. Printed by EXCEL BOOKS PRIVATE LIMITED A-45, Naraina, Phase-I, New Delhi-110028. - Project management. Mila Georgieva. (2015). STENO Publishing house.