الجمهورية الجزائرية الديمقراطية الشعبية
People's Democratic Republic of Algeria
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research
اللجنة البيداغوجية الوطنية لميدان العلوم و التكنولوجيا
National Pedagogical Committee for Science and Technology

HARMONIZATION TRAINING OFFER ACADEMIC MASTERS

2021 - 2022

Field	Branch	Speciality
Sciences and Technologies	***Process Engineering***	***Environmental Process Engineering***

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مواءمة

عرض تكوين
ماسترأكاديمي

2022-2021

الميدان	الفرع	التخصص
علوم و تكنولوجيا	هندسة الطرائق	هندسة الطرائق للبيئة

I – Master's Identity Card

Access conditions

Sector	Harmonized master	Access Licenses at the masters	Classification according to license compatibility	Coefficient assigned to the license
Process Engineering	***Environmental Process Engineering***	Process Engineering	**1**	**1.00**
		Materials Engineering	**2**	**0.80**
		Materials Chemistry (Domain SM)	**3**	**0.70**
		Physics of materials (Domain SM)	**3**	**0.70**
		Inorganic Chemistry (Domain SM)	**4**	**0.65**
		Other ST domain licenses	**5**	**0.60**

II- Half-yearly lesson organization sheets specialty

Semestre 1

Teaching unit	Matter	Crédit	Coefficient	Weekly hourly volume			Semester Hourly Volume (15 weeks)	Complementary work in Consultation (15 weeks)	Evaluation method	
	Entitled			Courses	TD	TP			Continuous monitoring	Review
Fundamental EU Code: UEF 1.1 Credits: 8 Coefficients: 4	Water Chemistry	4	2	1h30	1h30		45h00	55h00	40%	60%
	Atmospheric pollution	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental EU Code: UEF 1.2 Credits: 10 Coefficients: 5	Fluid-Fluid Unit Operations (extraction, distillation, absorption and stripping)	6	3	3h00	1h30		67h30	82h30	40%	60%
	Heat Transfer and Heat Exchangers	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological Unit Code: EMU 1.1 Credits: 9 Coefficients: 5	Practical Water Chemistry	2	1			1h30	22h30	27h30	100%	
	Practical Unit Operations (Fluid-Fluid)	2	1			1h30	22h30	27h30	100%	
	Practical work Thermal transfer and Heat exchangers	2	1			1h30	22h30	27h30	100%	
	Process engineering simulators	3	2	1h30		1h00	37h30	37h30	40%	60%

Discovery Teaching Unit Code: UED 1.1 Credits: 1	Course of choice	1	1	1h30			22h30	2h30		100%
	Course of choice	1	1	1h30			22h30	02h30		100%
Transversale Unit	Technical English and terminology	1	1	1h30			22h30	02h30		100%
Total semester		**30**	**17**	**13h30**	**6h00**	**5h30**	**375h00**	**375h00**		

Semestre 2

Teaching unit	Matter	Crédit	Coefficient	Weekly hourly volume			Semester Hourly Volume (15 weeks)	Complementary work in Consultation (15 weeks)	Evaluation method	
	Entitled			Courses	TD	TP			Continuous monitoring	Review
Fundamental EU Code: UEF 2.1 Credits: 10 Coefficients: 5	Production of drinking water	6	3	3h00	1h30		67h30	82h30	40%	60%
	Solid Waste Management and Treatment	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental EU Code: UEF 2.2 Credits: 8 Coefficients: 4	Adsorption Processes and Membrane Separation	4	2	1h30	1h30		45h00	55h00	40%	60%
	Polyphase Reactors	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological Unit Code: EMU 2.1 Credits: 9 Coefficients: 5	Porous and Dispersed Media	3	2	1h30	1h00		37h30	37h30	40%	60%
	Practical work Water treatment and Adsorption and Membrane Separation	2	1			1h30	22h30	27h30	100%	

	processes									
	Treatment and Conditioning of Process Water	4	1	1h30	1h30		22h30	27h30	40%	60%
Discovery unit	Course of choice	1	1	1h30			22h30	2h30		100%
	Course of choice	1	1	1h30			22h30	2h30		100%
Transversale Unit	Ethics, deontology and intellectual property	1	1	1h30			22h30	2h30		100%
Total semester 2		**30**	**17**	**15h00**	**8h30**	**1h30**	**375h00**	**375h00**		

Semestre 3

Teaching unit	**Matter**	Crédit	Coefficient	**Weekly hourly volume**			**Semester Hourly Volume (15 weeks)**	**Complementary work in Consultation (15 weeks)**	**Evaluation method**	
	Entitled			**Courses**	**TD**	**TP**			**Continuous monitoring**	**Review**
Fundamental EU Code: UEF 3.1 Credits: 10 Coefficients: 5	Physico-Chemical and Biological treatment of wastewater	6	3	3h00	1h30		67h30	82h30	40%	60%
	Gaseous Effluent Treatment	4	2	1h30	1h30		45h00	55h00	40%	60%

Fundamental EU Code: UEF 3.2 Credits: 8 Coefficients: 4	Applied Thermodynamics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Bioreactors	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological Unit Code: EMU 3.1 Credits: 9 Coefficients: 5	TP Physico-Chemical and Biological treatment of wastewater	2	1			1h30	22h30	27h30	100%	
	Process intensification	2	1	1h30			22h30	27h30	40%	60%
	Treatment of polluted soils	2	1	1h30			22h30	27h30	40%	60%
	Plans of experiments	3	2	1h30		1h00	37h30	37h30	40%	60%
Discovery unit	Course of choice	1	1	1h30			22h30	2h30		100%
	Course of choice	1	1	1h30			22h30	2h30		100%
Transversale Unit	Documentary research and dissertation design	1	1	1h30			22h30	2h30		100%
Total semester 3		**30**	**17**	**16h30**	**6h00**	**2h30**	**375h00**	**375h00**		

General guidelines on the choice of discovery materials:

-Treatment and recovery of WWTP sludge
- Technical and economic evaluation of the processes
- Environmental management
- Environmental audit and impact study
- Ecology and biodiversity
- Renewable energies
- Industrial risks and natural disasters
- chemical and biochemical sensors
- Climate change
- Environmental changes and biological invasion
- Biofuel cells
- Sonochemical Engineering
- Activation process
- Energy storage
- Renewable energies
- Biomass and biofuels
- Environmental standards and conventions
- Physico-chemical analysis methods
- Process Simulation and Optimization
- Environmental Microbiology and Biochemistry
- Process regulation and control

Semester 4

Internship in a company sanctioned by a dissertation and a defense
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	VHS	Coeff	Crédits
Personal work	550	09	18
Company internship	100	04	06
Seminars	50	02	03
Other (Framing)	50	02	03
Total Semester 4	750	17	30

This table is given for information only.

Evaluation of the End of Master Cycle Project

- Scientific value (Assessment of the jury) /6
- Dissertation writing (Jury assessment) /4
- Presentation and answer to questions (Assessment of the jury) /4
- Appreciation of the supervisor /3
- Presentation of the internship report (Assessment of the jury) /3

III - Detailed program by topic of semester S1

Semester: 1
Course unit: UEF 1.1
Topic 1: Water Chemistry
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Provide the basics of chemistry necessary for the analysis and resolution of an environmental problem; physico-chemical characterization of water with a view to assessing its quality and treatment.

Recommended prior knowledge:
Inorganic and Analytical Chemistry

Matter content:
First Part – Chemistry of natural waters 10 weeks
1. General
2- Properties of suspended solids
- Double layer theory
- Stability of colloidal suspensions
- Turbidity and turbidity units
- Determination of suspended solids
3- Materials in solution
- Major, fundamental and characteristic elements
- Units used in water analysis
- Verification of the water analysis
- Salinity or mineralization
- Hardnesses and hydrotimetric titles
- Alkalimetric titles and alkaline composition of the water
- Calcocarbonic balance and carbonic balances
- Water aggressiveness (Langelier index and graphs, Ryznar index, pH determination by calculation, Puckorius scaling index, Stiff and Davis index, Larson index, Leroy index, aggressiveness index)
Part Two – Wastewater Chemistry 5 weeks
1- Generalities and definitions
2- Characterization of residual and waste water
- Content of oxidizable matter
* Biochemical Oxygen Demand (BOD5)
* Chemical Oxygen Demand (COD)
* Total Organic Carbon (TOC)
- Nitrogen Kjeldahl (NTK)
- Weight content
* Suspended solids (SS)
* Suspended Volatile Solids (MVS)
- COD/BOD5 report

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references :
1. Monique Tardat-Henry, Jean-Paul Beaudry, Water Chemistry, Editions Le Griffon d'argile, 1992.
2. Patrick Brezonik, William Arnold, Water Chemistry: An Introduction to the Chemistry of Natural and Engineered Aquatic Systems, Oxford University Press, USA, 2011.

Semester: 1
Course unit: UEF 1.1
Topic 1: Air Pollution
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Acquisition of basic knowledge concerning the functioning of the atmospheric system and to provide the essential bases for understanding the major issues associated with air pollution.

Recommended prior knowledge:
Basic notions in general chemistry, chemical kinetics, thermodynamics.

Matter content:

1- Introduction
Chemical composition of the Earth's atmosphere, changes in levels, residence time of chemical species.
2- Vertical division of the atmosphere: layers, temperature and pressure gradient.
3- Sources of atmospheric pollution: anthropogenic (transport, industry, energy) and natural (volcanism, cows, lightning, pollen, etc.).
4- Effect of air pollution: on health, plants and materials.
5- Air pollutants: regulated and unregulated, units for expressing the concentration of pollutants, conversion between gravimetric and volumetric units, emission standards.
6- Atmospheric chemistry
Elements of kinetics and photochemistry, radical mechanisms, life time, photolysis.
Stratospheric ozone: ozone sources, catalytic cycles (NOx, ClOx), mechanisms of O3 destruction at high latitudes (ozone hole).
7- Tropospheric chemistry
Concept of oxidizing capacity, chemistry of the HOx/NOx/organic compound system, ozone production mechanisms, urban pollution (photochemical smog, PAN).
9- Atmospheric aerosols: definition, size, composition, formation process, primary and secondary aerosols, standards related to aerosols, aqueous phase atmospheric chemistry, application to acid rain.
10- Introduction to indoor air quality
- Emergence of interest in indoor chemical pollution.
- Main indoor air pollutants: Chemical pollutants (formaldehyde, radon, tobacco smoke, pesticides, volatile organic substances, etc.), Biocontaminants (mold, dust mites, allergens, etc.), Mineral particles and fibres.
- Sources of chemical compounds:
Continuous sources: construction and furnishing materials (insulation materials, wood products, paint, textile coating, varnish, glues and adhesives, new books, newspapers and magazines), Discontinuous sources (combustion of wood, gas, fuel oil, cooking food, smoking, candles, home fragrances and incense, etc.)
- Mode of human exposure and health risk: dermal absorption, inhalation

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1- J.C. Jones, Atmospheric pollution, Book Boon, VentusPublishing, 2008.
2- Louise Schriver-Mazzuoli, Indoor air pollution, Ed. Dunod, 2009.
3- Zhongchao Tan. Air Pollution and Greenhouse Gases, Springer-Verlag, 2014.

Semester: 1
Course unit: UEF 1.2
Topic 1: Fluid-Fluid Unit Operations (extraction, distillation, absorption and stripping)
VHS: 67h30 (Class: 3h00, TD: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:
At the end of this course, the student should be able to:

- Master the separative techniques of Process Engineering (absorption, extraction and distillation).
- Address the concepts of sizing and design of equipment.
- Know the main operating problems (priming, clogging, etc.).

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At the end of this course, the student should be able to:

- Master the separative techniques of Process Engineering (absorption, extraction and distillation).
- Address the concepts of sizing and design of equipment.
- Know the main operating problems (priming, clogging, etc.).

Recommended prior knowledge:

Thermodynamics, Differential equations, Transfer phenomena (matter transfer, fluid mechanics,..).

Matter content:

Chapter 1. Absorption and Stripping (5 Week)

Liquid-gas equilibrium, Solubility of gases as a function of pressure and temperature. Mass and enthalpy balances. Equipment used continuously. Theoretical and real stage concepts, Mac Cabe and Thièle method, concept of transfer units, sizing of packed columns, pressure drop, clogging speed. Complete sizing of a column with plates (Diameter of the column, weir, active surface, diameter of the holes, space between plate, entrainment of the solvent (devisicular). Absorption with chemical reaction. Stripping (regeneration of the solvent).

Chapter 2. Liquid – Liquid Extraction (4 Weeks)

Partition coefficient, selectivity, different types of diagrams. Equipment used continuously and discontinuously. Partially soluble solvent: co-current and counter-current multi-stage extraction (ternary diagram). Insoluble solvent: co-current and counter-current multi-stage extraction (Mac Cabe and Thièle construction), extraction with double feed, extraction with reflux. Stripping and recycling of the solvent, choice of the stripping phase And notion of efficiency.

Chapter 3. Distillation (6 Weeks)

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references:
1. Daniel Defives and Alexandre Rojey, Material Transfer, Efficiency of Chemical Engineering Separation Operations, TECHNIP Edition, 1976.
2. Robert E. Treybal, "Mass Transfer Operations", Third Edition, McGraw-Hill, 1980.
3. Warren L. McCabe, Julian C. Smith, Peter Harriott “Unit Operations of Chemical Engineering”, Mc Graw-Hill, Inc, Fifth Edition, 1993.
4. Jean LEYBROS, Liquid-liquid extraction - Description of devices, Engineering techniques Reference J2764 v1, 2004.
5. Unit Operations Handbook, Volume 1, Mass transfer, Edited by John J. Mcketta, 1993.
6. Daniel Morvan, Chemical Engineering: Unit Operations Industrial Processes Course and Corrected Exercises, Publisher: ELLIPSES, Colletion: Technosup, 2009.
7. Pierre Wuithier, Petroleum, Refining and Chemical Engineering, 2nd edition, 1972.

Semester: 1
Course unit: UEF 1.2
Topic 2: Thermal Transfer and Heat Exchangers
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 4
Coefficient:2

Teaching objectives:

Heat transfer, being part of the transfer phenomena, deals with the transfer of energy between two media. This phenomenon is present in various industrial applications in the field of Process Engineering as well as in other branches. Its objective is to complete the knowledge of the students and to teach them new notions such as heat transfer in transient state, conduction through the fins and in the presence of a heat source as well as heat exchangers, and calculation methods for heat transfer equipment.

Recommended prior knowledge:
Heat transfer, fluid mechanics, notions of mathematics (first and second order differential equations, calculation of integrals, etc.).

Matter content:

Chapter 1. Reminders of Heat Transfer Laws (1 Week)

Chapter 2. Heat Conduction (1 Week)
Chapter 3. Thermal Convection (2 Weeks)
Chapter 4. (2 Weeks)
Description of Heat Exchange Devices without Phase Change
Double tube exchangers, Core and shell heat exchangers (shell, core and core-shell assembly) and Plate heat exchangers.

Chapter 5. Calculation of Exchangers (3 Weeks)
Study of heat transfer (fundamental equations, average temperature difference, global transfer coefficient U), Study of pressure drops (Load loss inside the tubes, Pressure drop outside the tubes), Methods of calculation (Calculation of a double-tube heat exchanger,Calculation of a bundle and shell heat exchanger (Kern method)),General considerations on the calculation of a bundle and shell device and programming of the calculation.

Chapter 6.(3 Weeks)
Heat Exchange Devices with Phase Change
Description of the devices, condensation of a pure vapor (Film coefficients for condensation outside the tubes, Calculation of the condenser, Condensation preceded by a desuperheating of the vapor and followed by the cooling of the condensate), Condensation of a complex vapor (Calculation of the own transfer coefficient (Ward method and Kern method), Pressure drop in the shell, Example of calculation), forced circulation flooded reboilers (Reboiling of a pure substance in the shell, Reboiling of a mixture in the shell), Level Reboilers with Natural Circulation, Flooded Reboilers with Natural Circulation, example of Calculation of a Reboiler.

Chapter 7. Finned Tubes (2 Weeks)
1/ Integral low fins: Description, Efficiency, Overall heat exchanger transfer coefficient, Condensation film coefficient on horizontal finned tubes and Pressure drop.
2/ High fins: Description and study of air coolers.

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references:

1. J.F. Sacadura, Thermal transfers – Initiation and deepening, Ed. Lavoisier, 2015.
2. R.B Bird, W.E. Stewart, E.N. Lightfoot, Transport phenomena, 2nd Ed., Wiley & Sons, 2007.
A. Giovannini and B. Bédat, Heat transfer, Ed. Cépaduès, 2012.
3. James R. Welty, Charkes E. Qicks, Robert E. Wilson; Gregory Rorrer, Fundamentals of Momentum, Heat, and Mass Transfer. 4th edition Wiley & Sons, 2001.
4. Leontiev, Theory of Heat and Mass Exchanges – Mir-Moscow Edition
5. H.W. Mac Addams The transmission of heat - Dunod - Paris
6. F.P. Incropera, D.P. Dewitt - Fundamentals of Heat and Mass Transfer - Wiley, N.Y. - 2002
7. Bontemps, A. Garrigue, C. Goubier, J. Huetz, C. Marvillet, P. Mercier And R. Vidil – Heat exchanger – Engineering Techniques, Treatise on Energy Engineering
8. P. Wuithier, Petroleum, Refining and Chemical Engineering volume 2, Edition technip Paris

Semester: 1
Course unit: UEM1.1
Topic 1: Practical Water Chemistry
VHS: 22h30. (PT: 1h30.)
Credits: 2
Coefficient:1

Teaching objectives:
This subject aims to provide the basics of chemistry necessary for the analysis and resolution of an environmental problem. It concerns the physico-chemical characterization of water with a view to assessing its quality and treatment.

Recommended prior knowledge:
Chemistry of solutions, mineral and analytical

Matter content:

TP 1: Determination of salinity, pH and turbidity
Exercise 2: Determination of suspended solids
TP 3: Determination of the alkalimetric title and the complete alkalimetric title
TP 4: Determination of total hardness, calcium hardness and magnesium hardness
TP 5: Determination of chlorides
TP 6: Determination of dissolved oxygen
TP 7: Determination of biochemical oxygen demand (BOD5)
TP 8: Determination of the chemical oxygen demand (COD)
Exercise 9: Determination of total organic carbon (TOC)
TP 10: Determination of Kjeldahl nitrogen (NTK)
TP 11: Determination of volatile matter in suspension (MVS)

Assessment method:
Continuous control: 100%; Review: 0%.

Bibliographic references: (If possible)

1. Jean Rodier, Bernard Legube, Nicole Merlet, Water analysis. Natural waters, wastewater, seawater, Dunod edition, September 2016 - 10th edition.

Semester: 1
Course unit: UEM1.1
Topic 1: Practical work Unit operations (Fluid-Fluid)
VHS: 22H30 (PT: 1H30.)
Credits: 2
Coefficient:1

Teaching objectives:
• Allow the student to apply the theoretical knowledge acquired on a practical level and to visualize certain phenomena.
• Knowing how to work in a team, respecting the safety rules and controlling the risks associated with equipment, installations and processes.

Recommended prior knowledge:

Thermodynamics, transfer phenomena (matter transfer, fluid mechanics, etc.).

Matter content:

TP N° 1. Determination of the mutual solubility of two partially miscible liquids, water-phenol.
TP N° 2. .Extraction of volatile molecules by hydrodistillation.
TP N° 3. Separation of benzoic acid and 2-naphthol
TP N° 4. Study of a batch liquid-liquid extraction process.
TP N° 5. Study of some phase diagrams.
TP N° 6. Absorption of the CO2 contained in an air flow by water ("physical absorption").
TP N° 7. Absorption with chemical reaction and solvent regeneration: absorption of CO2 in amino acids.
TP N° 8. Liquid-gas absorption desorption.
Practical work N° 9. Realization of a water/oil/surfactant ternary diagram.
TP N° 10. Study of the operation of the column in total reflux
TP N° 11. Continuous rectification.
TP N° 12. Discontinuous distillation.
Practical work N° 13. Study of a continuous distillation process in a packed column or in a column with perforated plates.
TP N° 14.Separation and purification by fractional distillation: Case of esterification.

Assessment method:
Continuous control: 100%.

Semester: 1
Course unit: UEM1.1
Topic 1: TP Heat Transfer and Heat Exchangers
VHS: 22h30. (PT: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
- Experimentally quantify the various modes of heat transfer.
- Measure the thermal performance of different types of exchangers.
- Experimentally study equipment for the production, transport and use of steam.

Recommended prior knowledge:

Transfer phenomena, fluid mechanics.

Matter content:

TP N° 1. Heat transmission by conduction (basic unit).
TP N° 2. Linear heat conduction.
TP N° 3. Radial heat conduction.
TP N° 4. Convection and radiation
TP N° 5. Heat transmission by free and forced convection.

TP N° 6. Coaxial heat exchanger.

TP N° 7. Plate heat exchanger: enthalpy balances, efficiency curves, evaluation of transfer coefficients.

TP N° 8. Tube bundle heat exchanger.

Assessment method:
Continuous control: 100%.

Semester: 1
Course unit: UEM1.1
Topic 1: Process Engineering Simulators
VHS: 37h30 (Class: 1h30, Lab: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:
Through this module the student learns to design, size and simulate certain industrial processes related to chemical engineering using a computer code in the form of a simulator.

Recommended prior knowledge:
Knowledge of basic notions in transfer phenomena, thermodynamics and programming

Matter content:
Chapter 1 General introduction (5 weeks)
process design; From analysis to process control; Process simulators (Module-oriented and equation-oriented simulators, Simulator software environment: Properties server, Numerical methods for solving systems of equations, Library of unit operations);

Chapter II Process simulation without constraints (5 weeks)
General view ; Definition of a current; Choice of variables characterizing a material stream: Unit model equations, Connection equations, Specification equations); Strategies for solving the simulation problem (Global approach, Sequential modular approach, Standard data set); Simulation diagram; Sequential Solving: Advantages and Disadvantages of the Sequential Modular Approach

Chapter III Simulation of processes with constraints: CPAO (5 weeks)
Problems of the simulation of processes under constraint; Definition of CPAO – A detailed example: The different approaches (Simultaneous modular approach, Formulation); Implementation in the simulation software (Choice of the operator, Convergence); Relaxation factor.
Applications adapted to pollution treatment cases

Assessment method:
Continuous assessment: 40% and examination 60%

Semester: 1
Course unit: UED 1.1
Topic 1:Environmental Microbiology and Biochemistry
VHS: 22h30 (Class: 1h30.)
Credits: 1
Coefficient:1

Teaching objectives:
Acquire fundamental knowledge of microbiology and environmental biochemistry.

Recommended prior knowledge:
Basic notions of natural sciences

Matterl content:

Part One – MICROBIOLOGY 8 weeks
I-INTRODUCTION TO ENVIRONMENTAL MICROBIOLOGY
II-MORPHOLOGY AND FUNCTIONAL ANATOMY OF BACTERIA
III-BACTERIAL PHYSIOLOGY
a)-Nutrition
b)-Growth
IV-ROLE OF MICRO-ORGANISMS IN THE CYCLE OF BIO-ELEMENTS
a)-Characteristics of microbial ecosystems.
b)-Soil microbiology
c)-Microbiology of aquatic environments.
d)-Microbiology of the air.
V-MICROBIOLOGY OF THE AIR OF DOMESTIC WATER AND WASTE WATER.

Second Part - BIOCHEMISTRY 7 weeks
I - Introduction
a)-Molecular constituents of the cell.
b)-Notions of bioenergetics.
II- Proteins
a)-Structure and properties of amino acids.
b)-Structure and properties of proteins.
III- Enzymology
a)-Structure and mechanism of action of enzymes
b)-Complements of enzymatic kinetics
c)-Introduction to the enzyme genus.
IV- Microbial degradation of proteins
Nitrogen and sulfur cycle
V-Carbohydrates
a)-Structure and properties of monosaccharides.
b)-Structure and properties of carbohydrates
c)-Microbial degradation of cellulosic waste and the carbon cycle.
d)-The transport of electrons and the cycle of phosphorus, oxygen.
VI-Lipids
a)-Structure and properties of fatty acids.

b)-Structure and properties of lipids.
c)-Microbial degradation of petroleum residues, n-alkanes for example

Assessment method:
Review: 100%.

Bibliographic references: (If possible)
1. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press, 2nd Edition, 2013
2. K.G. Clarke, Bioprocess Engineering, Elsevier, 2013.

Semester: 1
Course unit: UET1.1
Topic 1:Technical English and Terminology
VHS: 22h30. (Class: 1h30 .)
Credits: 1
Coefficient: 1

Teaching objectives:
Introduce the student to technical vocabulary. Strengthen your knowledge of the language. Help him understand and synthesize a technical document. Enable him to understand a conversation in English held in a scientific setting.

Recommended prior knowledge:
Vocabulary and basic grammar in English

Material content:

- Written comprehension: Reading and analysis of texts relating to the specialty.

- Oral comprehension: From authentic video documents popularizing science, taking notes, summarizing and presenting the document.

- Oral expression: Presentation of a scientific or technical subject, elaboration and exchange of oral messages (ideas and data), Telephone communication, Gestural expression.

- Written expression: Extraction of ideas from a scientific document, Writing of a scientific message, Exchange of information in writing, writing of CVs, letters of application for internships or jobs.

Recommendation: It is strongly recommended that the person in charge of the subject present and explain at the end of each session (at most) about ten technical words of the specialty in the three languages (if possible): English, French and Arabic.

Assessment method:
Review: 100%.

Bibliographic references:

1. P.T. Danison, Practical guide to writing in English: customs and rules, practical advice, Editions d'Organisation 2007
2. A. Chamberlain, R. Steele, Practical guide to communication: English, Didier 1992
3. R. Ernst, Dictionary of applied techniques and sciences: French-English, Dunod 2002.
4. J. Comfort, S. Hick, and A. Savage, Basic Technical English, Oxford University Press, 1980

III - Detailed program by topic of semester S2

Semester: 2
Course Unit: UEF 1.2.1
Topic 1: Drinking water production
VHS: 67h30 (Class: 3h00, TD: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:
The aim of this course is to give students the tools they will need to manage drinking water production processes.

Recommended prior knowledge:
Water chemistry, solution chemistry, electrochemistry, matter transfer.

Matter content:

A- GENERALITIES AND STANDARDS (1 week)
General qualities of water from various supply sources; Quality standards; guidelines for water treatment; treatment channels

B- DRINKING WATER PRODUCTION PROCESSES (5 weeks)
- Micro-sieving (Theoretical aspects; Duration of use and Criteria for choosing a microsieve)
- Coagulation and flocculation (Suspended particles; Coagulation; Theory of flocculation)
-Decantation (Types of decantation, Decantation of discrete and flocculent particles; Decantation with tube and lamellas)
- Flotation (floaters, some performances)
- Filtration (General, Characteristics of filter materials, Water flow in a sand filter, bilayer filter)
- Disinfection (General principles; Disinfection by: chlorine, chlorine dioxide, ozone, UV, UV/hydrogen peroxide, etc.)

C- SPECIFIC DRINKING WATER PRODUCTION PROCESSES (8 weeks)
- Softening by precipitation
- Adsorption and ion exchange
- Elimination of iron and manganese
(Balance of iron and manganese; Iron removal and manganese removal processes)
- Water stabilization
- Water fluoridation and defluoridation
- Desalination of sea and brackish water
(Methods of desalination by: distillation, freezing, electrodialysis, reverse osmosis, etc.)
- Advanced oxidation processes
(Fenton, Electrofenton, Photofenton, UV/Ozone, UV/ozone/oxygenated water, sonochemistry, photocatalysis, plasma processes, electron gun, etc…)
- Swimming pool water treatment
(Purpose and Techniques of processing)

Assessment mode:
Continuous assessment: 40%; Review: 60%.

Bibliographic references:

B. Legube "Production of drinking water", Edition Dunod, Paris
J.B. BEAUDRY “Water treatment” Edition le Griffon d’argile, Sainte-Foy, (Canada)
DEGREMONT "Technical memento of water" T1 and T2, Technical Edition and Documentation, Paris
Water treatment unit processes; W.J. Masschelein
Feedwater microbiology; C. Hasley, H. Leclerc
Water treatments for the engineer - Physico-chemical and biological processes - Courses and problems solved; C. Cardot
Water treatment; R.Desjardins
Treatment and purification of polluted industrial water: membrane processes, bioadsorption and chemical oxidation; G. Crini, P. M. Badot

Semester: 2
Course Unit: UEF 1.2.1
Topic2: Solid Waste Management and Treatment
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 4
Coefficient:2

Teaching objectives:
The aim is to introduce students to the problem of solid waste, the impact of which on the environment and on public health is well established. It is a question of studying the different possibilities of waste treatment according to their nature.

Matter content:
Introduction
Definition of waste, classification of waste, characterization, ultimate waste, legislation.
1- Household waste
1-1- Waste collection
Type of collection, collection equipment, collection route, transfer stations.
1-2- Landfill
Problems of uncontrolled landfills, technical landfill centre, waste eligible for class I, II and III CET, technical characteristics of CET (passive safety, active safety and cover), treatment of leachate and recovery of biogas, sizing of CET.
1-3- Bioconversion of organic waste
1-3-A- Composting
Benefits of composting, compostable waste, composting parameters, composting phases, composting methods, determining compost maturity, vermicomposting.
1-3-B- Methanization
Methanizable waste, importance of methane in industrial processes, methanization phases, methanization parameters, dry and wet fermentation, biogas treatment, types of digesters.
1-4- Incineration
Purpose, products from the incineration of household waste, incineration parameters, post-treatments (gas, fly ash and bottom ash), types of furnaces.
1-5- Recycling
Importance of recycling, recycling logos, recyclable and non-recyclable waste, importance of selective sorting in recycling.
2- Special industrial waste (DIS)
Definition, types, production sources, hazard criteria, nomenclature, storage.
Treatments:
- Physico-chemical: neutralization, chemical precipitation, oxidation/reduction, sorption, stabilization/solidification, well injection.
- Heat treatments: incineration, pyrolysis, hydrothermal oxidation, vitrification.
3- Healthcare waste at risk of infection (DASRI)
Types of medical waste, legislation, sorting, packaging and marking, storage, transport.
Treatments: by incineration, autoclave sterilization, chemical disinfection, microwave irradiation.

Assessment mode: Continuous monitoring: 40%; Review: 60%.

References

1- George Tchobanoglous, Frank Kreith, Handbook of Solid Waste Management, McGraw-Hill, 2002.
2- Daniel A. Vallero, J. Jeffrey Peirce, Engineering the Risks of Hazardous Wastes, Ed. B.H. 2003.
3- Lawrence K. Wang, Nazih K. Shammas Yung-Tse Hung, Advances in Hazardous Industrial Waste Treatment, CRC Press, 2009.

Semester: 2
Course Unit: UEF 1.2.2
Topic 1: Adsorption Processes and Membrane Separation
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 4Coefficient:2

Teaching objectives:
The goal is to give:
- The theoretical bases necessary to implement an adsorbent and the sizing of adsorbers of various types: discontinuous, semi-continuous and continuous.
- In-depth theoretical and practical knowledge in the field of membrane techniques and familiarize them with the latest technological advances in membranes.

Recommended prior knowledge:
Transfer phenomena (matter transfer, fluid mechanics, etc.), surface chemistry and heterogeneous catalysis.

Matter content:

Part One: Adsorption Processes (6 Weeks)

Chapter 1. Main industrial adsorbents, selection criteria, regeneration methods, main industrial applications.
Chapter 2. Dynamics of adsorption (preceded by a reminder of the general laws of physical adsorption).
Chapter 3. Discontinuous processes.
Chapter 4. Separation processes by adsorption
- Pressure modulated.
- Temperature modulated.

Part Two: Membrane Separation Processes

Chapter 1. Generalities and definitions (1 Weeks)
Chapter 2. Membranes (3 Weeks)
Structure, characterization and membrane modules of industrial facilities.
Chapter 3. Membrane Separation Technique (5 Weeks)
Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis and Electrodialysis.

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references:

1. Unit Operations Handbook, Volume 1, Mass transfer, Edited by John J. Mcketta, 1993.
2. Warren L. McCabe, Julian C. Smith, Peter Harriott “Unit Operations of Chemical Engineering”, Mc Graw-Hill, Inc, Fifth Edition, 1993.
3. J. P. Brun, Membrane separation processes, Transport Techniques membranes Applications, Masson, Paris, 1988.

4. Robert E. Treybal, "Mass Transfer Operations", Third Edition, McGraw-Hill, 1980.

Semester: 2
Course Unit: UEF 1.2.2
Topic 3: poly-phase reactors
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 4
Coefficient:2

Teaching objectives:
The student will have acquired knowledge concerning the operation of heterogeneous poly-phase reactors such as absorbers, catalytic reactors, combustion reactors and other heterogeneous two-phase reactors.

Recommended prior knowledge:
Basic knowledge of homogeneous reactors, chemical kinetics and transfer phenomena is recommended.

Matter content:

Chapter 1. Fluid-Fluid Two-Phase Reactors (6 Weeks)
1- Introduction; -Effect of the chemical reaction on the transfer of matter
(Theory of the two films; Pseudo-first-order reaction-Hatta number (Ha); Rapid reaction regime-Acceleration factor E; Instantaneous reaction regime-Diagram E as a function of Ha.); -Calculations of two-phase reactors (batch reactors, piston reactors, perfectly stirred continuous reactors.
Chapter 2. Catalytic Fluid-Solid Reactors (6 Weeks)
1- Intra-particle diffusion
(Number of Thièle; Efficiency).
2- Efficiency and transfer of external material
(Effect of catalyst grain diameter; External material transfer).
3- Influence of internal diffusion on the reaction (Weisz-Prater criterion); Influence of external mass transfer on the reaction (Mears criterion).
4- Fixed bed reactors. ; Fluidized bed reactors.
Chapter 3. Non-Catalytic Fluid-Solid Reactors (3 Weeks)
Shrinkingcore sphere model.
Assessment mode: Continuous monitoring: 40%; Review: 60%.

Bibliographic references:
1. Roustan M: Gas/liquid transfer in water and gaseous effluent treatment processes, Tec § Doc Lavoisier, Paris (2003) ISBN: 2-7430-0605-6
2. Schweich D: chemical reaction genius, Tec! Doc lavoisier (2001) ISBN: 2-7430-0459-2
3. R.Missen, C.Mims and B.Saville: Chemical reactions engineering and kinetics, John Wiley and Sons, new York (1999)
4. Levinspiel O: chemicalreaction engineering, 3rd edition, John Wiley and Sons, New York (1998) ISBN: 0471225424X
5. Villermaux J: Chemical reaction engineering, design and operation of reactors, 2nd edition, Tec § Doc Lavoisier, Paris (1993) ISBN: 2-85206-132-5
6. Atkinson B and Mayituna F: Biochemical engineering and biotechnology hand book, Ed Mac Millan (1991) ISBN: 978-033342-4032

7. Froment G and Bischoff KB: Chemical reactor, analysis and design: John Wiley and Sons, New York (1979)

Semester: 2
Course unit: UEM 1.2.1
Topic 1: Porous and Dispersed Media
VHS: 37h30 (Class: 1h30, TD: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:
All of these lessons should allow a good knowledge of Process Engineering operations for the treatment of liquids and gases.
Recommended prior knowledge:
Unit operations

Matter content:

Chapter 1. Solid Operations
Definitions. Grain morphology and stacking. Properties of solids. Grinding. Screening. Sieving.
Chapter 2. Motions of particles in a fluid
Flow of fluids around grains. Vertical movement of particles or globules in the field of gravity. Equation of motion (terminal velocity). Collective fall of particles in a fluid.
Chapter 3. Fluid flow through a porous medium
Flow of a single fluid through a bed. Dispersion. Heat transfer in a fixed bed. Filled columns. Flow of a suspension. Constant flow filtration. Filtration at constant pressure. Ruth's law. Case of squeezable cakes.
Chapter 4. Fluidization
Characteristics of fluidized systems. Liquid-solid systems. Gas-solid systems. Fluidized beds (gas-solid). Transfer of heat and matter between the fluid and the particles.
Chapter 5. Sedimentation
Sedimentation of fine particles. Sedimentation of large particles. Kynch's theory. Sizing of a decanter.

Chapter 6.Filtering
Filter theory. Filtration at constant flow, at constant pressure. Ruth's law. Case of squeezable cakes.

Assessment mode: Continuous monitoring: 40%; Review: 60%.

Bibliographic references:
1. Coulson J.M., J.F Richardson, J.R Backhurst And J.H. Harker, "Chemical Engineering", volume two, Fifth edition, Pergamon Press, 2002.
2. Rhodes, M., Introduction to ParticleTechnology, 2nd Ed., Wiley (2008).
3. Gibilaro, L.G., Fluidization - Dynamics, Butterworth - Heinemann (2001).
4. Perry R. H., D. W. Green And J. O. Maloney, "Perry's Chemical Engineers' Handbook " seventh edition, , McGraw Hill, 1999
5. Kunii D. And O. Levenspiel, "Fluidization Engineering", second ed. Butterworth-Heinemann, 1991.
6. Darton R.C., "Fluidization", ed. by J.F. Davidson, R. Clift and D. Harrison, Academic Press, 1985.

7. McCabe W.L., J.C. Smith and P. Harriott, "Unit Operations of Chemical Engineering", seventh edition, ed. McGraw Hill, 2004

Semester: 2
Course unit: UEM 1.2.1
Topic 2: Practical work Water treatment and Adsorption processes and Membrane separation
VHS: 22h30 (TP: 1h30.)
Credits: 2
Coefficient:1

Teaching objectives:
The objective is to present the treatment processes most often used by engineers to produce drinking water.

Recommended prior knowledge:
Water chemistry, physico-chemical methods of analysis

Matter content:

Water treatment
• Coagulation-flocculation
• Decarbonation with lime
• Ion exchange
• Settling
• Clarification
• Filtration
• Membrane processes

Adsorption Processes and Membrane Separation
• Separation of a dye in aqueous phase by adsorption.
• Separation of a pesticide in aqueous phase by adsorption.
• Equilibrium in the heterogeneous system: experimental determination of the adsorption isotherm of CH3COOH, dissolved in water, by a solid substance (activated carbon).
• Extraction by emulsified liquid membrane.
• Preparation and stabilization of an emulsion

Evaluation mode: Continuous monitoring: 100%

Bibliographic references:

• J.B. BEAUDRY “Water treatment” Edition le Griffon d’argile, Sainte-Foy, (Canada)
• DEGREMONT "Technical memento of water" Technical Edition and Documentation, Paris
• W.W. ECKENFELDER “Management of urban and industrial wastewater” Technical Edition and Documentation; Paris
• M.J. HAMMER “Water and waste-water technology” Edition John Wiley & sons, New York
• Warren L. McCabe, Julian C. Smith, Peter Harriott “Unit Operations of Chemical Engineering”, McGraw-Hill, Inc, Fifth Edition, 1993.
• J. P. Brun, Membrane Separation Processes, Transport Membrane Techniques Applications, Masson, Paris, 1988

Semester: 2
Course unit: UEM 1.2
Topic 3: Treatment and Conditioning of Process Water
VHS: 45h00 (Class: 1h30; TD: 1h30)
Credits: 4
Coefficient:2

Teaching objectives:
The aim is to acquire theoretical and practical knowledge on the treatments necessary to use water as an energy and thermal fluid in order to eliminate the problems of fouling, scaling, corrosion, biological developments, water quality, which arise directly from the use of this fluid.

Recommended prior knowledge:
Water chemistry

Matter content:

Chapter I: Cooling waters
I.1. Introduction
I.2. Storage of raw material
I.3. Energy Conservation
I.4. Water conservation and treatment
I.5. Chemistry of water used as thermal fluid
Chapter II: Treatment of boiler water
II.1. Position of the problem
II.2. Boiler water specifications
II.3. Supplements on boiler water treatment
II.3.1. Degassing
II.3.2. Phosphate treatment
II.3.3. Corrosion inhibitors
II.3.4. Anti-priming conditioning
II.4. Processing channels
II.4.1. Low pressure boilers
II.4.2. Medium pressure boilers
II.4.3. High pressure boilers
II.4.4. Condensate treatment before recycling
Chapter III: Cooling water treatment
III.1. Position of the problem
III.2. The cooling circuits
Open Circuits, Totally Closed Circuits and Semi-Closed Circuits
III.3. Problems posed by cooling circuits
Scaling, Dirt and Corrosion.
III.4. Cooling water treatment
III.4.1. Open circuits
III.4.2. Semi-closed circuits:
Treatment of the make-up, Characterization of the cooling circuit, Treatment of purges and Treatment in bypass.

Assessment mode: Continuous monitoring: 40%; Review: 60%.
Bibliographic references:

Semester: 2
Course unit: UET 1.2
Topic: Ethics, deontology and intellectual property
VHS: 22h30 (Class: 1h30.)
Credit: 1
Coefficient: 1

Teaching objectives:

Develop student awareness of ethical principles. Introduce them to the rules that govern life at the university (their rights and obligations vis-à-vis the university community) and in the world of work. Make them aware of the respect and valuation of intellectual property. Explain to them the risks of moral evils such as corruption and how to combat them.

Recommended prior knowledge:

None

Matter content:

A- Ethics and deontology

I. Notions of Ethics and Deontology (3 weeks)

1. Introduction
1. Definitions: Morality, ethics, deontology
2. Distinction between ethics and deontology
2. Charter of ethics and professional conduct of the MESRS: Integrity and honesty. Academic freedom. Mutual respect. Requirement of scientific truth, objectivity and critical thinking. Equity. Rights and obligations of the student, teacher, administrative and technical staff.
3. Ethics and deontology in the world of work
Legal confidentiality in business. Loyalty to the company. Responsibility within the company, Conflicts of interest. Integrity (corruption in work, its forms, its consequences, methods of fighting and sanctions against corruption)

II. Integrity and responsible research (3 weeks)

1. Respect for the principles of ethics in teaching and research
2. Responsibilities in teamwork: Professional equality of treatment. Conduct against discrimination. The search for the general interest. Inappropriate conduct in the context of collective work
3. Adopting responsible conduct and combating excesses: Adopting responsible conduct in research. Scientific fraud. Conduct against fraud. Plagiarism (definition of plagiarism, different forms of plagiarism, procedures to avoid unintentional plagiarism, detection of plagiarism, sanctions against plagiarists, etc.). Falsification and fabrication of data.

B- Intellectual property

I- Fundamentals of intellectual property (1 week)

1. Industrial property. Literary and artistic property.
2. Rules for citing references (books, scientific articles, communications in a congress, theses, dissertations, …)

II- Copyright (5 weeks)

1. Copyright in the digital environment
Introduction. Database copyright, software copyright. Specific case of free software.

2. Copyright in the internet and electronic commerce
Domain name rights. Intellectual property on the internet. Law of the e-commerce site. Intellectual property and social networks.

3. Patent
Definition. Rights in a patent. Usefulness of a patent. Patentability. Patent application in Algeria and worldwide.

4. Trademarks, designs and models
Definition. Trademark Law. Design law. Denomination of origin. The secret. Counterfeit.

5. Geographical Indication Law
Definitions. Protection of Geographical Indications in Algeria. International Treaties on Geographical Indications.

III- Protection and enhancement of intellectual property (3 weeks)

How to protect intellectual property. Violation of rights and legal tool. Valuation of intellectual property. Protection of intellectual property in Algeria.

Assessment method:
Review: 100 %

Bibliographic references:

1. Charter of ethics and university deontology, https://www.mesrs.dz/documents/12221/26200/Charte+fran__ais+d__f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce
2. Orders No. 933 of July 28, 2016 setting the rules relating to the prevention and fight against plagiarism
3. The ABCs of Copyright, United Nations Educational, Scientific and Cultural Organization (UNESCO)
4. E. Prairat, On teacher ethics. Paris, PUF, 2009.
5. Racine L., Legault G. A., Bégin, L., Ethics and Engineering, Montreal, McGraw Hill, 1991.
6. Siroux, D., Deontology: Dictionary of Ethics and Moral Philosophy, Paris, Quadrige, 2004, p. 474-477.
7. Medina Y., Ethics, what will change in the company, editions of Organization, 2003.
8. Didier Ch., Thinking about the ethics of engineers, Presses Universitaires de France, 2008.
9. Gavarini L. and Ottavi D., Editorial. professional ethics in training and research, Research and training, 52 | 2006, 5-11.
10. Caré C., Morality, ethics, deontology. Administration and education, 2nd quarter 2002, n°94.
11. Jacquet-Francillon, Francois. Concept: professional ethics. Le Télémaque, May 2000, n° 17
12. Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.
13. Galloux, J.C., Industrial Property Law. Dalloz 2003.
14. Wagret F. and J-M., Patents, trademarks and industrial property. PUF 2001
15. Dekermadec, Y., Innovating through patents: a revolution with the internet. 1999

16. AEUTBM. The engineer at the heart of innovation. Belfort-Montbeliard University of Technology
17. Fanny Rinck and Léda Mansour, literacy in the digital age: copy-paste among students, Université Grenoble 3 and Université Paris-Ouest Nanterre la Défense Nanterre, France
18. Didier DUGUEST IEMN, Citing your sources, IAE Nantes 2008
19. Similarity detection software: a solution to electronic plagiarism? Report of the Working Group on electronic plagiarism presented to the CREPUQ Sub-Committee on Pedagogy and ICT
20. Emanuela Chiriac, Monique Filiatrault and André Régimbald, Student guide: intellectual integrity plagiarism, cheating and fraud… avoiding them and, above all, how to properly cite your sources, 2014.
21. Publication of the University of Montreal, Plagiarism prevention strategies, Integrity, fraud and plagiarism, 2010.
22. Pierrick Malissard, Intellectual property: origin and evolution, 2010.
23. The website of the World Intellectual Property Organization www.wipo.int
24. http://www.app.asso.fr/

IV- Detailed program by topic of semester S3

Semester: 3
Course unit t: UEF 2.1.1
Topic 1: Physico-chemical and biological treatment of waste water VHS: 67h30 (Course: 3h00, TD: 1h30)
Credits: 6 Weight:3

Teaching objectives:
The content of this module must be sufficiently provided to enable students to understand the fundamentals of biological wastewater treatment and to be able to size treatment plants.

Recommended prior knowledge:
Fundamentals of Chemistry and Process Engineering

Matter content:
Introduction to Wastewater Treatments

Characterization of wastewater:
From the quantity point of view (staffing, average flow, peak coefficient, max flow in dry weather, max flow in rainy weather), flow measurement companion and equipment
From the quality point of view (characterization parameters of pollution (BOD, COD, MES, Nitrogen, Phosphorus, oils and grease, hydrocarbon, toxic elements (heavy metals, Temperature, pH,) determination and calculation), characterization of EU companion d sampling and characterization
Basic data for sewage treatment plant projects

Wastewater Treatment Objectives and Schemes
Objectives of wastewater treatment: Protection of receiving environments (oued, dam, groundwater, sea), protection of public health, reuse of treated wastewater (agriculture, industry, etc.), groundwater recharge,
Treatment diagrams considering (pre-treatments, primary treatments, secondary treatments, tertiary and advanced treatments, storage), etc. sludge treatment)
Physical treatments

Screening (objective, different types of grids, calculation of pressure drops for a clean and clogged grid, determination of the approach speed and the speed of passage, quantity of scrap retained))
Aerated sand removal (objective, operation, calculation of dimensions, calculation of air needs, calculation of the quantity of sand retained,)
Buffer basin (objective, operation, calculation,)
Sedimentation and settling (objectives, discrete sedimentation, flocculant sedimentation, lamellar sedimentation, zone sedimentation and compressive sedimentation),

sizing of primary and secondary settling tanks (shape, inlet, outlet weir, bottom, sludge extraction system, etc.)
Oxygen transfer in aquatic environments

Biological treatments
• Objectives and introduction to biological treatment
• Composition and classification of microorganisms
• Introduction to bacterial metabolism and biological reaction (carbon sources and energy sources, nutritional needs of microorganisms)
• Conversion
• Bacterial growth and Monod kinetics (Monod model and biokinetic constants; specific growth rate, substrate utilization rate, oxygen consumption rate)
• Determination of Monod's bio-kinetic constants
Activated sludge
• Type of activated sludge (high load, medium load and prolonged aeration) concept of sludge age and mass load;
• Development of the balance of the activated sludge system with return (age of the sludge, mass load, determination of the concentrations of the substrate and the biomass at the outlet, volume of the aeration tank, quantity of excess sludge, need for oxygen and air,)
• Sizing of an activated sludge system
• Use of activated sludge for the elimination of carbonaceous load and nitrogen;
• Use of activated sludge for the elimination of the carbon load, nitrogen and phosphorus,
Biological filters
Membrane reactors Lagoon systems

Sludge treatment
• Determination of the quantities of sludge generated in a biological treatment system;
• Sludge treatment diagram
• Thickening
• Aerobic digesters
• Anaerobic digesters
• Drying bed
• Filter press

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references:.

Semester: 3
Course unit: UEF 2.1.1
Topic 2: Treatment of Gaseous Effluents VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4 Weight:2

Teaching objectives:

Make students aware of the different gas and dust treatment processes produced by fixed and mobile units.

Recommended prior knowledge:

Matter content:

Chapter 0. Reminders
Ideal gas laws, units and dimensions, conversions, concentration calculations.

Chapter 1 Measurement of Gases and Particles
(Sampling and analysis).

Chapter 2. Processes for treating pollution from stationary sources A- Treatment of gaseous effluents
Absorption, Adsorption, Thermal oxidation, Catalytic oxidation, Condensation, Biofiltration, Flaring.

B- Dust treatment
Bag filters, Cyclone, Venturi, Electrofilter.

Chapter 3.Treatment of pollution from mobile sources
Gasoline and diesel vehicles: pollutants emitted, emission standards, catalytic converters, two-way, three-way catalysts, etc.

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references:.

1- Kenneth C. Schifftner, Air Pollution Control Equipment Selection Guide, Lewis publishers, 2002.
2- Nicholas P. Cheremisinoff, Handbook of Air Pollution Prevention and Control, B.H. Ed. 2002.
3- Lawrence K. Wang, Yung-Tse Hung, Nazih K. Shammas, Advanced Physicochemical Treatment Processes, Handbook of Environmental Engineering, Vol. 4, Ed. HumanaPress, 2006.

Semester: 3
Subject: UEF 2.1.2
Topic 1: Applied Thermodynamics
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 4
Coefficient:2

Teaching objectives:

Study of thermodynamic cycles and master the operating principles of certain energy technologies, namely: thermal machines, compressors, pumps, etc.

Recommended prerequisite knowledge

Chemical thermodynamics, fluid mechanics.

Subject content

Chapter 1. (8 Weeks)

Carnot cycle of thermal machines, thermal efficiency. Internal combustion engine. Gas turbine. Steam engine (Rankine cycle, HIRN cycle, reheat cycle, withdrawal cycle, with representation in the various diagrams ((T,S), (P,V) and (H,S)).

Chapter 2. (4 Weeks)

Compressors and pumps (compressor cycle, work, efficiency and calculation of the number of stages. Installation of pumps (characteristic curve, head, NPSH available, NPSH required, yield).

Chapter 3. (3 Weeks)

Cold: Thermodynamic study (inverted Carnot cycle). Real refrigeration cycles. Heat pumps. Gas liquefaction (LINDE and CLAUDE processes)

Assessment method:

Continuous control: 40%; Exam: 60%.

References

1. Gordon Van Wylen, Richard Sonntag, Thermodynamique appliquée, Editeur Erpi, Collection : Diffusion Pearson Education, 2002.

2. https://hal.inria.fr/file/index/docid/556977/filename/CycleThermoMachines_1011.pdf

3. http://www.emse.fr/~bonnefoy/Public/Machines_Thermiques-EMSE.pdf

4. Olivier Cleynen, Thermodynamique de l'ingénieur, Collection Frama book, 2015.

5. Paul Chambadal, la turbine à gaz, Collection de la direction des études et recherches d'électricité de France, EYROLLES, 1976.

6. Jean Lemale, Les pompes à chaleur, 2éme Edition DUNOD, Paris, 2012, 2014

Semester: 3
Course Unit: UEF 2.1.2
Topic 2: Bioreactors
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Introduction of the basic concepts necessary for the implementation of the design and analysis of bioreactors on an industrial scale

Recommended prior knowledge:

Material content:

I- Introduction (2 weeks)
Reminders of the basic knowledge of microbiology, biochemistry and molecular biology necessary for the calculation of bioreactors

II- Modeling reaction rates in biological systems (3 weeks)
- Microbial kinetics: Monod model
- Enzyme kinetics
- Inhibition of enzymatic reactions

III- Design and analysis of bioreactors (5 weeks)
- Types of bioreactors
- Basic concepts
- Batch bioreactors
- Continuous stirred tanks
- Plug-in bioreactors
- Comparison of batch bioreactors and continuous bioreactors IV- Sterilization (2 weeks)
- Physical sterilization
- Chemical sterilization

V- Material transfer in bioreactors (3 weeks)
- Aeration: gas-liquid material transfer
- Agitation: material transfer by forced convection

Assessment method:

Continuous control: 40%; Review: 60%.

Semester: 3
Course unit: UEM 2.1
Topic 1: Practical work Physico-Chemical and Biological treatment of wastewater VHS: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
Put into practice the theoretical notions acquired in class

Recommended prior knowledge:
Basic notions of chemistry and process engineering

Material content:

1st group of practical work: Characterization of wastewater
• COD, BOD5, TOC, Kjeldahl nitrogen and total nitrogen, MVS, microbiological parameters 2nd group of practical work: Pre-treatments and Physico-chemical treatment
• Pre-treatments: Screening, Desanding, De-oiling and degreasing, Sieving
• Settling and sedimentation

3rd group of practical work: Biological treatment and disinfection
• Biological treatments
• Disinfection of purified water 4th group of practical work: Tertiary treatments

NB: It is recommended to do at least six practical exercises, chosen from the different groups, according to the means available.

Assessment method:
Continuous control: 100%.

Bibliographic references :

Semester: 3
Teaching unit: UEM 2.1
Topic 2: Intensification of processes
VHS :22h30 (Course: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

1- Understand the principle of process intensification
2- Apply intensification techniques for various processes

Recommended prior knowledge:
Material and heat transfer, catalysis, reactors, unit operations.

Matter content:

Chapter 1. Basics of Process Intensification
Definitions.Principles and applications of PI.Implementation of process intensification: approach based on equipment or methods.

Chapter 2. Equipment for Process Intensification
Microreactors: Oscillating baffle reactors, Rotating disc reactors
- Centrifugal absorber
- Rotating packed columns
- Examples of application of this equipment in different processes

Chapter 3. Methods of Process Intensification
Multifunctional reactors (Reactive distillation, Membrane reactors). Hybrid separations (Membrane-absorption, Membrane-distillation). Examples of applications of these different methods.
Chapter 4. Alternative Energy Sources
Solar energy. Ultrasound. Microwaves.

Chapter 5. Other Methods of Process Intensification:
New solvents (supercritical fluids, ionic liquids). Examples of application of these solvents.

Assessment mode: Continuous monitoring: 40%; Review: 60%.

Bibliographic references:
1. Stanckiewicz, A., and Moulijn. Marcel Dekker, Re-engineering the Chemical Processing Plant-Process Intensification. Inc. N.Y. 2003.

Semester: 3
Teaching unit: UEM 2.1
Topic 3: Treatment of polluted soils
VHS: 22h30 (Course: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
Sites polluted by the infiltration of polluting substances linked to the operation of industrial installations constitute a risk for surface and underground water and for the use of the soil as habitat, crops or the establishment of activities. The aim of this course is to inform students of the different existing techniques for decontaminating sites polluted by different organic and mineral compounds.

Recommended prior knowledge:

Material content:

1- Introduction
Soil formation, soil types, analysis of polluted soils, properties of organic and inorganic contaminants, regulations, pollution in unsaturated and saturated zone, in situ, on site and off site treatments.

2- Physico-chemical methods
Venting, Soil washing (leaching), Stripping, Stabilization/solidification, Chemical oxidation, Chemical reduction, Dual-phase extraction, Containment by covering and sealing, Vertical containment, Hydraulic trap (containment).

3- Thermal methods
Thermal desorption, Incineration, Vitrification, Pyrolysis.

4- Biological methods
Phytoremediation, Boosted biodegradation, Controlled natural attenuation, Bioventing, Biotertre, Composting.

Assessment method:
Continuous control: 40%; Review: 60%.

References

1- John Pichtel, Fundamentals of Site Remediation: For Metal and Hydrocarbon-Contaminated Soils, 2007.
2- Helmut Meuser, Soil Remediation and Rehabilitation, Treatment of Contaminated and Disturbed Land, 2013.
3- Rainer Stegmann, Gerd Brunner, Wolfgang Calmano, Gerhard Matz, Soil Treatment of Contaminated Soil, Springer, 2001.

Semester: 3
Course unit: UEM 2.1
Topic 4: Design of experiments
VHS: 37h30 (Class: 1h30, Lab: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:
Allow a good mastery of experimental manipulations and make the results more significant.
Recommended prior knowledge:
Basic notions in mathematics

Material content:
Chapter 1: General introduction and factorial plans
1. Introduction
2. What is a design of experiment
3. Study domain and response surface
4. Factors
5. Notion of interaction
6. Notion of model and multiple linear regression 7. Complete 2k factorial plan
7.1. Example calculation of effects
7.2. The graphical representation of the effects
7.3. Matrix Form - Multilinear Regression
8. Application example
Chapter 2: Significance tests and model validation
1. Introduction
2. Experimental errors
3. Significance of effects tests
4. Confidence interval of model effects
5. Analysis of variance. Validation of the linear model
5.1. The "ANOVA" table
5.2. Coefficient of determination-Correlation coefficient
6. Application example
Chapter 3: Fractional Plans
1. Introduction
2. Design of a fractional plan
3. Fractional Plan Analysis
4. Application example
5. Other Plans: Plackett-Burman Plans and Taguchi Plan

Chapter 4: Response Surface Plans
1. Introduction
2. Notion of response surface and isoreponse curves 3. Plans for the study of quadratic models
3.1. Map Box-Behnken
3.2. Centered composite plane
4. Criteria of quality and optimality of an experimental design
4.1. Calculation of optimal plans
5. Example of application of response surface plans

Chapter 5: Mixing planes
1. Introduction
2. Geometric representation of mixtures
3. Area of Study in Mixing Plans
4. Mathematical models of mixtures 5. Analysis of a mixture plan
6. Application example
7. Mixing plans and design of experiments: mixed plans

Apps
- Introduction to Minitab software + Obtaining the coefficients of a complete design as well as the graphs of the main effects and interactions + ANOVA.
- Fractional designs in Minitab
- Optimization by response surface plans (Box Benkhen + Central composite)
- Use of mixing planes

Assessment mode: Continuous assessment: 40%; Review: 60%.

Bibliographic references:

Semester: 3
Course unit: UET 2.1
Topic 1: Documentary research and memory design
VHS: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Give the student the necessary tools to find useful information to better use it in his graduation project. Help him through the different steps leading to the writing of a scientific document. Make him aware of the importance of communication and teach him to present the work carried out in a rigorous and educational manner.

Recommended prior knowledge:
Writing methodology, Presentation methodology.

Matter content:

Part I-: Documentary research:

Chapter I-1: Definition of the subject (02 Weeks)
- Subject title
- List of keywords concerning the subject
- Gather basic information (acquisition of specialized vocabulary, meaning of terms, linguistic definition)
- The information sought
- Take stock of your knowledge in the field

Chapter I-2: Selecting sources of information (02 weeks)
- Type of documents (Books, Theses, Dissertations, Periodical articles, Conference proceedings, Audiovisual documents, etc.)
- Type of resources (Libraries, Internet…)
- Assess the quality and relevance of information sources

Chapter I-3: Locating documents (01 Week)
- Research techniques
- Search operators

Chapter I-4: Processing information (02 weeks)
- Work organization
- The starting questions
- Summary of selected documents
- Links between different parties
- Final plan of the documentary research

Chapter I-5: Presentation of the bibliography (01 Week)
- The systems for presenting a bibliography (The Harvard system, The Vancouver system, The mixed system, etc.)
- Presentation of documents.
- Citation of sources

Part II: Memory Design

Chapter II-1: Dissertation plan and stages (02 weeks)
- Identify and delimit the subject (Summary)
- Issues and objectives of the dissertation
- The other useful sections (Acknowledgements, Table of abbreviations, etc.)
- The introduction (Writing the introduction last)
- State of the specialized literature
- Formulation of hypotheses
- Methodology
- Results
- Discussion
- Recommendations
- Conclusion and perspectives
- Table of contents
- The bibliography
- Annexes

Chapter II- 2: Writing techniques and standards (02 weeks)
- Formatting. Numbering of chapters, figures and tables.
- Cover Page
- Typography and punctuation
- Writing. Scientific language: style, grammar, syntax.
- Spelling. Improved general linguistic competence in terms of comprehension and expression.
- Save, secure, archive your data.

Chapter II-3: Workshop: Critical study of a manuscript (01 week)

Chapter II-4: Oral presentations and defenses (01 Week)
- How to present a Poster
- How to present an oral communication.
- Defense of a dissertation

Chapter II-5: How to avoid plagiarism? (01 Week)
(Formulas, sentences, illustrations, graphs, data, statistics,...)
- The quote
- The paraphrase
- Indicate the complete bibliographic reference

Assessment method:
Review: 100%

Bibliographic references:

1. M. Griselin et al., Guide to written communication, 2nd edition, Dunod, 1999.
2. J.L. Lebrun, Practical guide to scientific writing: how to write for the international scientific reader, Les Ulis, EDP Sciences, 2007.

3. A.Mallender Tanner, ABC of technical writing: manuals, user manuals, online help, Dunod, 2002.
4. M. Greuter, Writing your dissertation or internship report well, L'Etudiant, 2007.
5. Mr. Boeglin, read and write in college. From chaos of ideas to structured text. The Student, 2005.
6. M. Beaud, the art of the thesis, Editions Casbah, 1999.
7. M. Beaud, the art of the thesis, Discovery, 2003.
8. M. Kalika, Master's thesis, Dunod, 2005.