Direction de la Formation
et de la Vie Universitaire

Commission de la Formation et de la Vie Universitaire

UNIVERSITÉ TOULOUSE III PAUL SABATIER
Université de Toulouse
DIRECTION GÉNÉRALE DES SERVICES

Approbation de l'ouverture d'un nouveau parcours « Master in Membrane Engineering for Sustainable Development (Erasmus+) » au sein du Master GPBP de la FSI

Commission de la Formation et de la Vie Universitaire du 08 février 2022

Délibération 2022/02/CFVU – 20

Vu le code de l'éducation, notamment son article L.712-6-1 ;

Vu les statuts de l'Université Toulouse III – Paul Sabatier, notamment son article 35 ;

Après en avoir délibéré, les conseillers approuvent l'ouverture d'un nouveau parcours « Master in Membrane Engineering for Sustainable Development (Erasmus+) » au sein du Master Génie des Procédés et des Bio-Procédés de la Faculté Sciences et Ingénierie.

Toulouse, le 08 février 2022

UNIVERSITE PAUL SABATIER TOULOUSE

Le Président

Jean-Marc BROTO

Nombre de membres : 40 Nombre de membres présents ou représentés : 30	Nombre de voix favorables : 30 Nombre de voix défavorables : 0 Nombre d'abstentions : 0 Ne prennent pas part au vote : 0 Nombre de votes blancs : 0

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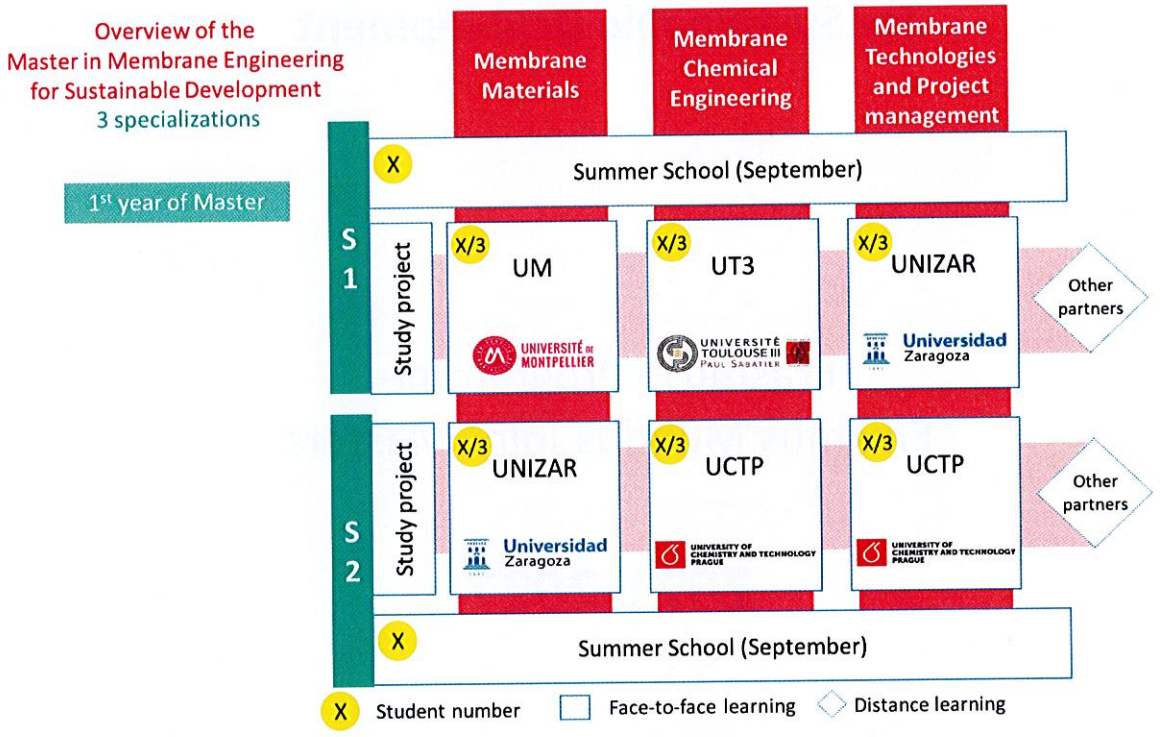
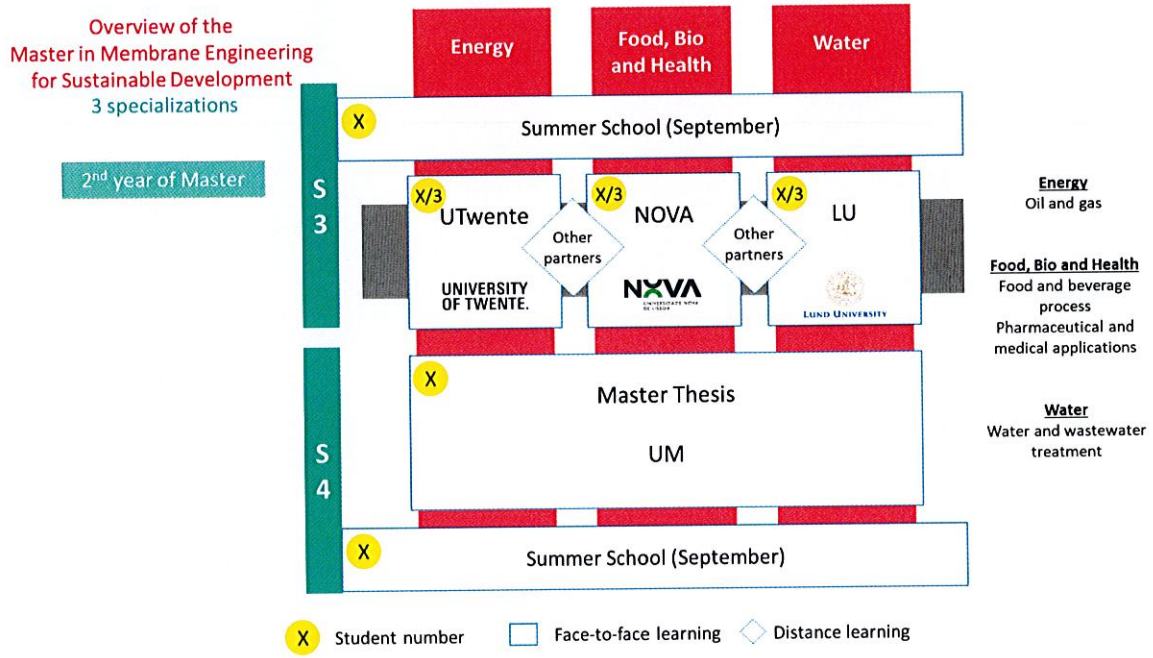
Master in Membrane Engineering for Sustainable Development

Erasmus+ Programme
Erasmus Mundus Joint Masters

2021-2027

Overall architecture for the programme





Content of the programme

Master 1

Membrane Materials MemMAT (30 ECTS)			
Semester 1 - UM			
Course	***Type***	***ECTS***	***Responsibility***
Polymers	Mandatory	2	UM
Advanced inorganic materials	Mandatory	2	UM
Polymers and biodegradable polymers for sustainable development	Mandatory	2	UM
Characterization of porous materials	Mandatory	2	UM
Design of membrane materials	Mandatory	2	UM
Transport phenomena	Mandatory	2	UM
Influence of processing properties on the properties of materials	Mandatory	2	UM
Numerical modeling and simulations	Mandatory	2	UM
Applications of membrane technologies	Mandatory	2	UM
Tutored projects	Mandatory	8	UM
Solutions, colloids, interfaces	Mandatory	2	UM
TOTAL ETCS UM		**28**	
External contributions			
Introduction to nanomaterials	Mandatory On-line	2	UNIZAR
Entrepreneurship and Innovation Online Course (33ECTS UM)	Mandatory On-line	3	NOVA
TOTAL ECTS SEMESTER 1		**30**	
Semester 2 - UNIZAR			
Course	***Type***	***ECTS***	***Responsibility***
Individual Project	Mandatory	9	UNIZAR
Characterization I: Physical-chemical Techniques	Mandatory	6	UNIZAR
Characterisation II: Advanced microscopies	Mandatory	6	UNIZAR
Fabrication of micro and nanodevices	Mandatory	5	UNIZAR
TOTAL ETCS UNIZAR		**26**	
External contributions			
Hybrid and structured materials	Mandatory On-line	2	UM
Thermal and mechanical properties	Mandatory On-line	3	NOVA
TOTAL ECTS SEMESTER 2		**30**	
TOTAL TRACK		**60**	

Membrane Chemical Engineering MemENG (30 ECTS)			
Semester 1 -UT3			
Course	***Type***	***ECTS***	***Responsibility***
Transport phenomena (Basic knowledge in chemical engineering)	Mandatory	3	UT3
Separation Science (Basic knowledge in chemical engineering).	Mandatory	6	UT3
Colloid and surface engineering(Basic knowledge in chemical engineering)	Mandatory	3	UT3
Life cycle analysis, Security, norm and risk (application)	Mandatory	3	UT3
Bioseparation science(application)	Mandatory	3	UT3
Project (application)	Mandatory	6	UT3
Practical Labs	Mandatory	3	UT3
TOTAL ETCS UT3		**27**	
External contributions			
Entrepreneurship and Innovation Online Course	On-line	3	NOVA
TOTAL ECTS SEMESTER 1		**30**	
Semester 2 -UCTP			
Course	***Type***	***ECTS***	***Responsibility***
Membrane Processes	Mandatory	4	UCTP
Process Design	Mandatory	5	UCTP
Individual Project 2	Mandatory	7	UCTP
Applied Reaction Kinetics	Mandatory	5	UCTP
Human Resources Management Systems	Mandatory	6	UCTP
Valorisation, Commercialisation and Entrepreneurship (Could be shared by 2-3 tracks S2)	Mandatory	3	UCTP
TOTAL ETCS UCTP		**30**	
TOTAL ECTS SEMESTER 2		**30**	
TOTAL TRACK		**60**	

Membrane Technologies and Project Management (30 ECTS)			
Semester 1 -UNIZAR			
Course	***Type***	***ECTS***	***Responsibility***
Organizations and their human resource management	Mandatory	4.5	UNIZAR
Industrial and R&D project management	Mandatory	6	UNIZAR
Economy and Industrial Organization	Mandatory	6	UNIZAR
Ecodesign and life cycle analysis	Mandatory	3	UNIZAR
Team project-Team work with the other tracks if possible	Mandatory	7.5	UNIZAR
TOTAL ETCS UT3		**27**	
External contributions			
Entrepreneurship and Innovation Online Course	On-line	3	NOVA
TOTAL ECTS SEMESTER 1		**30**	
Semester 2 -UCTP			
Course	***Type***	***ECTS***	***Responsibility***
Membrane Processes	Mandatory	4	UCTP
Process Design	Mandatory	5	UCTP
Individual Project 2	Mandatory	7	UCTP
Applied Reaction Kinetics	Mandatory	5	UCTP
Human Resources Management Systems	Mandatory	6	UCTP
Valorisation, Commercialisation and Entrepreneurship available in MemENG (Could be shared with the other tracks)	Mandatory	3	UCTP
TOTAL ETCS UCTP		**30**	
TOTAL ECTS SEMESTER 2		**30**	
TOTAL TRACK		**60**	

Master 2

Energy (30 ECTS)			
Semester 3 - UTwente			
Course	***Type***	***ECTS***	***Responsibility***
Advanced colloids & Interfaces	Mandatory	5	UTWENTE
Multicomponent mass transfer	Mandatory	5	UTWENTE
Membranes for gas separations	Mandatory	5	UTWENTE
Membrane process plant design	Mandatory	5	UTWENTE
Electrochemistry: Fundamentals & Technology	Mandatory	5	UTWENTE
Capita selecta	Mandatory	5	UTWENTE
TOTAL ETCS UTwente		**30**	

Food, bio and health (30 ECTS)			
Semester 3 - NOVA			
Course	***Type***	***ECTS***	***Responsibility***
Membranes in Food Applications and Biorefinery	Mandatory	6	NOVA
Membranes in Biomedicine	Mandatory	6	NOVA
Business Project	Mandatory	6	NOVA
Engineering Project	Mandatory	6	NOVA
Membranes in Downstream Processing	Mandatory	6	NOVA
TOTAL ETCS NOVA		**30**	
TOTAL ECTS SEMESTER 3		**30**	

Water (30 ECTS)			
Semester 3 - LU			
Course	***Type***	***ECTS***	***Responsibility***
Integrated Water Resources Management: International Aspects VVRF01	Mandatory	7.5	LU
Water and Wastewater Treatment VVAN25	Mandatory	7.5	LU
Project Course Part I VVAN10	Mandatory	7.5	LU
Project Course Part II VVAN15	Mandatory	7.5	LU
TOTAL ETCS LU		**30**	
TOTAL ECTS SEMESTER 3		**30**	

Master Thesis (30 ECTS)			
Semester 4			
Course	***Type***	***ECTS***	***Responsibility***
Research assignment in industry or university (24 weeks)	Mandatory	30	UM
TOTAL ETCS UM		**30**	
TOTAL ECTS SEMESTER 4		**30**	
TOTAL MASTER 2		**60**	

Membrane Materials MemMAT (30 ECTS)

SEMESTER 1

Course name	**Polymers**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Lecturer(s)					
Activities	**Lectures :** 13h **Tutorials:** 7h **Practicals:** 0h				
Used sources					
Short description of course contents	Introduction / review of polymers (brief history of polymers, structure, molar mass distributions, dispersity) Synthesis by controlled radical polymerization Step polymerization of multifunctional monomers: synthesis of gels and other crosslinked materials Modification of surfaces by polymers (grafting, chemisorption, etc.) New applications of polymers (self-healing, vitrimers, etc.)				
Competencies acquired by the student	Basic knowledge in Material Science				
System for assessment and evaluation					
Key words	Recent development in polymer synthesis, controlled radical polymerization (RAFT-NMP-ATRP) ROP				

Course name	**Advanced inorganic materials**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 13h **Tutorials:** 7h **Practicals:** 0h				
Lecturer(s)					
Used sources					
Short description of course contents	Classification of inorganic materials Properties - structures relationship Traditional and advanced synthesis methods: ceramurgy, mechanosynthesis, sol-gel, hydrothermal, preceramic polymers, 3D printing, ALD ... Oxide ceramics, non-oxide ceramics (carbides, nitrides), Clays, Zeolites, Glasses, Vitroceramics, Metals, Metal alloys, Hydrides				
Competencies acquired by the student	Basic knowledge in Material Science				
System for assessment and evaluation					
Key words	Glass, Ceramics (powders, thin layers), Metals Zeolites-clays, Synthesis - characteristics - applications				

Course name	**Polymers and biodegradable polymers for sustainable development**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 11h	**Tutorials:** 9h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	Degradation and biodegradation: process, issues, assessment method, legislation and standards. Agropolymers, synthetic degradable polymers, biocomposites Synthesis of polymers: enzymatic polymerization, organocatalysis polymerization Environmentally friendly polymerization techniques: polymerization in aqueous medium Recyclability Application of polymers in pollution control				
Competencies acquired by the student	Advanced knowledge in Material Science				
System for assessment and evaluation					
Key words	Synthetic degradable polymers-Biosourced polymers Biocomposites, Enzymatic polymerization, Degradation and biodegradation, Recycling, Applications of depollution polymers				

Course name	**Characterization of porous materials**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 11h	**Tutorials:** 9h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	Presentation of the interfacial phenomena at the origin of the textural characterization (specific pore and external surface, pore volume, IUPAC classification of porosity, different pore shapes, gas adsorption / desorption and capillary condensation, physical adsorption mechanisms in macropores, mesopores and micropores, adsorption type I, II and IV isotherms, different hysteresis loop shapes, wetting / immersion, adsorption from solutions) Textural characterization methods based on the use of probe molecules (analysis of nitrogen adsorption isotherms, adsorption models of Langmuir, Brunauer, Emmett, Teller and Dubinin – Radushkevich; point B method; aS- methods plot and t-plot; Dubinin – Radushkevich model; DFT method; Harkins-Jura method; Hg porosimetry; helium and water pycnometry; thermoporometry) Microscopic and optical methods of textural and granulometric characterization of divided and porous solids (optical, electron, atomic force, acoustic microscopies; laser granulometry, dynamic light scattering, ellipsometry coupled with gas adsorption; X-ray diffraction coupled with gas adsorption) Textural and granulometric analysis of examples of porous and divided materials studied in the Montpellier laboratories, critical analysis of examples of characterization taken from scientific articles.				
Competencies acquired by the student	Advanced knowledge in Material Science				
System for assessment and evaluation					
Key words	Description of porous materials - definitions. Static characterization techniques; Dynamic characterization techniques				

Course name	**Design of membrane materials**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 11h		**Tutorials:** 9h	**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	Polymer membranes, Inorganic membranes, Phase inversion processes, Ceramic processes (including additive approaches), Dry deposition processes, Chemical modification				
Competencies acquired by the student	Advanced knowledge in Material Science				
System for assessment and evaluation					
Key words	Polymer processes (phase inversion, etc.), Ceramic processes (including additive methods), Dry deposition processes, Chemical modification				

Course name	**Transport phenomena**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 11h	**Tutorials:** 9h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	Introduction to transport phenomena - Flux Extensive size assessments - Global assessment Local assessment - Continuity equation Phenomenological laws of the transport of matter and heat Heat transport Heat conduction modes Conduction Convection Radiation Introduction to heat exchangers Material transport Modes of material transfer Diffusion Convection Migration of charged matter in an electric field Concept of boundary layers (matter and heat) - Dimensional analysis Transport phenomena and chemical reaction - Coupled phenomena Illustration of the course through case studies				
Competencies acquired by the student	Advanced knowledge in Material Science				
System for assessment and evaluation					
Key words	Fluid dynamics, Material transfer, Heat transfer, Coupled transfer in processes, Material and energy balance				

Course name	**Influence of processing properties on the properties of materials**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 11h	**Tutorials:** 9h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	Reminder of thermodynamic principles (Free enthalpy of mixing) Phenomena of phase separation, crystallization, gelation, solidification in polymeric materials Formalization of transfer phenomena associated with the morphogenesis of materials Use of dimensionless numbers from Process Engineering for the calculation of extensivity flows Change of scale operation Responsive environment and sizing				
Competencies acquired by the student	Advanced knowledge in Material Science				
System for assessment and evaluation					
Key words	Space and / or time scales, Scale change tools, Process sizing, Unit operations (drying, mixing, ...)				

Course name	**Numerical modeling and simulations**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 11h	**Tutorials:** 9h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	Introduction to modeling and numerical simulation, top-down and bottom-up approaches 0D modeling of the distribution of residence times in a process 0D modeling of reactive systems in RPAs using spreadsheet tools Process simulation using dedicated tools Modeling and simulation at the local scale using digital calculation code type tools				
Competencies acquired by the student	Advanced knowledge in Material Science				
System for assessment and evaluation					
Key words	Modeling of transfer couplings, Control of the morphology of membranes at different scales, Prediction of clogging phenomena, Applications to improving filtration processes				

Course name	**Applications of membrane technologies**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 11h	**Tutorials:** 9h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	Membranes, Filtration / purification, Water treatment, Gas / vapor separation, Energy This course will address the main conventional membrane technologies in liquid and gas media. Regarding the liquid medium, baromembrane technologies such as microfiltration, ultrafiltration, nanofiltration and reverse osmosis, but also those based on gradients of electrochemical potential (electro deionization) or temperature (membrane distillation) will be mainly described. In addition, gas permeation and pervaporation for the separation of gases and / or vapors will also be presented. For all technologies, the question of the choice of suitable membrane materials will be addressed and representative examples of appropriate fields of use (in connection with current environmental and energy issues) will be given.				
Competencies acquired by the student	Advanced knowledge in Material Science				
System for assessment and evaluation					
Key words	water treatment, energy, gas separation …				

Course name	**Tutored projects**				
ECTS Credits	8	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures : 5h**	**Tutorials: 5h**	**Practicals: 40h**		
Lecturer(s)					
Used sources					
Short description of course contents	Introduction to scientific ethics Bibliographic search Risks and safety in chemicals Preparation for the defense / writing a report in English 40-hour experimental work on an industrial or academic issue: Synthetic and analytical approaches in relation to the course chosen by the student Use of synthesis and analysis equipment (synthetic microwave, hydrothermal, FT-IR spectroscopies, Raman, NMR, mass spectrometry, scanning electron microscope, chromatography systems, etc.)				
Competencies acquired by the student	Autonomy, project management, handling on pilots				
System for assessment and evaluation					
Key words	Study projects on a proposed subject (theory and practice)				

Course name	**Solutions, colloids, interfaces**				
ECTS Credits	2	**Track/Semester**	MemMAT - S1	**Type**	Mandatory
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 7h	**Tutorials:** 13h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	1) General information on dispersed systems and on interfacial mechanisms: notions and basic concepts relating to multi-component systems as a function of the size of dissolved or dispersed substances (molecular dispersion vs. colloidal dispersion, colloidal size, colloidal emulsions and suspensions, supramolecular organized systems of amphiphiles and polymers in aqueous solution, example of colloids in speciation diagrams); mastery of colloidal stability (surface energy and interfacial tension, work of division of matter - calculation examples, main types of interactions in colloidal systems, Brownian motions, metastability, adsorption from solutions, ionic double layer, DLVO model , stability by electrostatic repulsions and steric stability, flocculation, coagulation, coalescence, Ostwald ripening, micellar solubilization); properties of colloidal systems (Tyndall effect, osmotic pressure, electrophoresis, hydrophilic-lipophilic balance, viscosity and multiphase flows) 2) Examples of applications of colloidal mechanisms and systems				
Competencies acquired by the student	Basic knowledge in Material Science				
System for assessment and evaluation					
Key words	Colloidal dispersions: interfacial energy, colloidal stability, properties, Associative colloids (surfactants) and macromolecular solutions (polymers), Formulation of colloidal dispersions and organized systems, Behavior of dissolved and colloidal substan				

SEMESTER 2

Course name	**Individual Project**				
ECTS Credits	9	**Track/Semester**	MemMAT - S2	**Type**	Mandatory
Course coordinator				**HEI**	Universidad de Zaragoza
Activities	**Lectures :** 6h	**Tutorials:** 12h		**Practicals:** 80 h	
Lecturer(s)					
Used sources					
Short description of course contents	In this subject the student is introduced in a research project, devoted to the development and integration of new materials in membranes. The project integrates the knowledge acquired in S1 about different materials. The student will select materials for membrane preparation, based on the requirements of the specific membrane application. In a second step the student will search for scientific literature on the specific project, and after that synthesized and characterize membranes. At this stage the student will apply the knowledge of characterization techniques acquired in S1 and S2. The first two weeks consist of lectures about challenges presented for different membrane applications and the influence and requirements of membrane materials. Several projects will be presented and selected by students. Then the student will work in the lab in this project over a period of 10 weeks an average of 8 hours per week. Appart from that, autonomous study and writing report will be accomplished. During the assignment the student will be tutorized. The student would have regular meetings every week for discussion.				
Competencies acquired by the student	Bibliographic search and selection of the information. To develop a scientific methodology Interpretation of characterization techniques Presentation of scientific results				
System for assessment and evaluation	The evaluation will be through a written project and oral presentation at the end of the assignment				
Key words					

Course name	**Characterization I: Physical-chemical Techniques**				
ECTS Credits	6	**Track/Semester**	MemMAT - S2	**Type**	Mandatory
Course coordinator				**HEI**	Universidad de Zaragoza
Activities	**Lectures :** 20h		**Tutorials:** 10h	**Practicals:** 32h	
Lecturer(s)					
Used sources					
Short description of course contents	This course, is aimed at instructing the student in the different methods available for the characterization of materials and in their practical application to obtain morphological, structural, analytical, optical, electric or magnetic information of interest. The contents of the course include: Introduction to surface preparation and characterization. Photoelectron spectroscopies (XPS and UT3). Auger Spectroscopy (AES). SANS techniques X-ray and neutron diffraction. Mössbauer spectroscopy. Techniques based on the use of sinchrotron radiation. Zeta potential, DLS, FTIR, Raman and Raman-SERS Spectroscopies. Quartz Crystal Microbalance (QCM) and Electrochemical techniques.				
Competencies acquired by the student	- Identify specific phenomena and problems for which this kind of tool can provide vital information for the characterization of nanostructured materials. - Distinguish the contributions of morphological, structural, analytical and magnetic nature of different basic nanoscience techniques - Assess the observation difficulties linked to the resolution of the tools and the environmental conditions in which the measurements are taken. - Understand the type of information provided by each characterization method - assuming that complete analysis requires the complementary information obtained from several of these techniques. - Design experiments to clarify the composition, structure, morphology or properties of a material on the nanoscale.				
System for assessment and evaluation	Assessment of the 2 ECTS theory credits of the subject (33% of the final mark): a.- Written exam (50% of the theory credits) + Problem solving, exercises and questions set during the classes responded to individually by the student in the same classes or handed in after to the lecturer giving the class (50% of the theory credits). Assessment of the 4 ECTS practical credits of the module (67% of the final mark) The lecturers will assess (scored between 1 and 10) several aspects of the practical which may include, depending on each practical, abilities and skills of the students in the laboratory, instrument handling ability, accuracy performing experiments, attention to detail, ability to solve problems or unforeseen difficulties that may arise, ability to work on experiments in a group, and answers to multiple choice questions and Q&As laid out before, during and/or after the practical sessions.				
Key words	XPS, FTIR, Raman, SANS techniques X-ray and neutron diffraction, DLS, QCM, Electrochemical characterization.				

Course name	**Characterisation II: Advanced microscopies**				
ECTS Credits	6	**Track/Semester**	MemMAT - S2	**Type**	Mandatory
Course coordinator				**HEI**	Universidad de Zaragoza
Activities	**Lectures :** 30h	**Tutorials:** 5h		**Practicals:** 30h	
Lecturer(s)					
Used sources					
Short description of course contents	This subject will show the student the advanced microscopes (electronic, dual-beam and scanning probe) that allow the morphology and topography of nanostructured materials to be studied with nanometric resolution in addition to being powerful analytical tools, determining electric and magnetic properties at the molecular scale and allowing the handling of the substance at atomic and molecular scale.				
Competencies acquired by the student	Distinguish the contributions of morphological, structural, chemical, electric and magnetic nature of different advanced microscopes. Assess the observation difficulties linked to the resolution of the tools and the experimental conditions in which the me				
System for assessment and evaluation	1. Assessment of the **3 ECTS theory credits** of the course (50% of the final mark): a) Problem solving, exercises and questions set during the theory sessions, responded to individually by the student in the same classes or handed in after to the lecturer giving the class (25% of the final mark). With these questions, the student must show knowledge about electronic microscopes and SPM. Specifically, the following will be assessed: the right approach to solving the question or problem, correct solution, interpretation of the results and explanation of how the problem was solved, giving equations or graphs where necessary. b) Monographic Report by groUT3 (2-3 students) related to some of the topics in the syllabus which will be presented to a board of examiners (25% of the final mark). Through this report, the results of the learning process will be assessed with regard to the abilities required for the module such as bibliographic search, data interpretation, oral and written communication skills, interaction with colleagues and professionals from other areas, etc. Specifically in the report, the following aspects will be assessed: i) structure (logical division of content); ii) quality of scientific and technical content (presentation of state of art, correct use of formulae, use of consistent arguments, and correct presentation of most important conclusions); iii) good use of bibliography (number and quality of sources consulted); iv) presentation (well written, correct and fluent use of English, care taken over style). The following aspects are assessed in the oral presentation: i) structure (logical division of content) and good distribution of time; ii) good scientific communication (concise presentation, direct, clear and pedagogical); iii) correct use of audiovisual equipment. 2. Assessment of the **3 ECTS practical credits** (50% of the final mark): The lecturers for the practicals will score between 1 and 10 on different aspects, depending on each specific practical, such as instrument handling skills, accuracy when performing experiments, attention to detail, ability to resolve unforeseen problems or difficulties that may arise, and/or answering questions proposed by the practical teachers which include questions on the theoretical bases on which the practicals are based as well as the analysis and interpretation of the results obtained in the laboratory.				
Key words	Scanning electron microscopy.Transmission electron microscopy (image and diffraction). Analysis techniques linked to electron microscopy: energy dispersive X-ray spectroscopy and electron energy loss spectroscopy. Atomic and magnetic force microscopy.				

Course name	**Fabrication of micro and nanodevices**				
ECTS Credits	6	**Track/Semester**	MemMAT - S2	**Type**	Mandatory
Course coordinator				**HEI**	Universidad de Zaragoza
Activities	**Lectures :** 10h	**Tutorials:** 10h		**Practicals:** 40h	
Lecturer(s)					
Used sources					
Short description of course contents	The objective of this module is that the students can make their own nano- or microdevices, experiencing the potential applications and becoming familiar with the practical and real application of the material studied in the previous courses. This module is mainly practical and the students will make and characterize their own devices, evaluating the practical applications of these. The theory classes will focus on explaining the theory upon which the devices the students will make in the laboratory is based. The students will have access to sophisticated production and characterization equipment.				
Competencies acquired by the student	Understand and successfully prepare micro and nanodevices. Design and create nanodevices, assessing real difficulties in their production and in the requirements for these to reach the marketplace. Identify and, with rigour, describe some of the recent specific developments in research that have led to nanotech applications. Find opportunities to apply theory and knowledge of the phenomena taking place at the nanoscale for the making of devices and specific applications. Assess the true difficulties that come with the practical pursuit of an idea or concept.				
System for assessment and evaluation	Assessment of the practical credits of the course (80% of the final mark). The lecturers involved will score from 1 to 10: the abilities in the lab, fundamental knowledge on which the practical is based, and/or the Q&As and reports handed in by the students on their laboratory results and the interpretation of these. Special attention will be paid to checking that students have acquired the necessary abilities from these practical sessions, i.e. handling of nanomaterial production techniques, recognition of experimental difficulties in these processes, problem, risk and difficulty evaluation, interpretation of results obtained, professional presentation of laboratory-acquired results and written communication ability with specific language appropriate to the topic under consideration. The lecturers involve in the theoretical fundamentals supporting the laboratory sessions will assess problem solving, exercises and questions during the classes answered by the student at that time or later according to the lecturer's indications (20% of the final mark).				
Key words	Microsensors, Micromembranes, Optical biosensors, Electrochemical sensors, Organic light-emitting diodes (OLEDs), Microfluidic Technology for the synthesis of Plasmonic Nanoparticles, Magnetic Contrast Agents for Biomedical Applications, Quantum Dots, Solar Cells				

Course name	**Hybrid and structured materials**				
ECTS Credits	2	**Track/Semester**	MemMAT - S2	**Type**	External contribution
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 10h	**Tutorials:** 10h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	"Hybrid" materials constitute a new family of materials, associating organic ligands connecting inorganic entities, is being studied more and more both at the fundamental and application level. Two main categories of hybrid materials will be discussed: - Coordination Networks and Metal-Organic Frameworks - Organosilicate / carbon materials				
Competencies acquired by the student	Basic knowledge in Material Science				
System for assessment and evaluation					
Key words	hybrid materials, mesostructured silica, Metal Organic Frameworks, Lamellar materials, carbon nanotubes and graphene				

Course name	**Thermal and mechanical properties**				
ECTS Credits	2	**Track/Semester**	MemMAT - S2	**Type**	External contribution
Course coordinator				**HEI**	Université de Montpellier
Activities	**Lectures :** 11h	**Tutorials:** 9h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	Thermal properties - Macroscopic microscopic link; temperature electrons and phonons; heat capacity (thermal energy storage application) -Thermal conductivity; heat diffusion law (building insulation application) -Thermal expansion; microscopic appearance and binding anharmonicity; atypical effects (negative, massive expansion, etc.) (technological applications) -Melting and heat resistance (thermal shock) -Diffusivity in materials -thermoelasticity Mechanical properties - Introduction / definitions: what are we called mechanical properties? - Stress / strain relations: stresses: normal, tangential deformations: tension, shear, expansion stress-strain curve: elastic domain (Hooke), plastic, necking definition of the different types of materials - Elastic domain: definition of the different elastic moduli (Bulk, shear, Young, Poisson) introduction of elastic constants Cij elastic energy density expression of elastic moduli as a function of Cij application to cubic, quadratic, orthorhombic crystals				
Competencies acquired by the student	Basic knowledge in Material Science				
System for assessment and evaluation					
Key words	basic knowledge in solid mechanics and deformation of solid metals - glasses - polymers - ceramics and composites macroscopic laws of behavior, Thermal Properties				

Membrane Chemical Engineering MemENG (30 ECTS)

SEMESTER 1

Course name	**Transport phenomena**				
ECTS Credits	3	**Track/Semester**	MemENG - S1	**Type**	Mandatory
Course coordinator				**HEI**	UT3
Activities	**Lectures :** 15h	**Tutorials:** 15h		**Practicals:** 0h	
Lecturer(s)	Yannick Hallez, Patrice Bacchin				
Used sources	*1. Bird, Stewart and Lightfoot, Transport Phenomena* *2. Guyon, Hulin and Petit, Physical hydrodynamics*				
Short description of course contents	1. Fluid dynamics (momentum transfer) : viscosity, friction factor, drag coffcient, permeability, Bernoulli's theorem 2. Heat and Mass transfer : diffusion and advection mechanisms, transfers at interfaces, boundary layers, dimensionless numbers 3. Coupled transfer phenomena 4. Macroscopic mass and heat balance				
Competencies acquired by the student	1. To know general concepts about transport phenomena and the analogy between momentum, mass and heat transfer 2. To be able to develop momentum, mass and heat balances to determine velocity, concentration or temperature fields 3. To be able to use adimensional corelations to estimate friction, mass transfer or heat transfer coefficients at interfaces 4. To know the consequences of the coupling of transport phenomena in major processes 5. To be able to evaluate the limiting transport phenomena in a processes through the calculation of an adimensionnal number				
System for assessment and evaluation	Classical exam				
Key words	Heat and mass transfer, fluid mechanics				

Course name	**Separation Science**				
ECTS Credits	6	**Track/Semester**	MemENG - S1	**Type**	Mandatory
Course coordinator				**HEI**	UT3
Activities	**Lectures :** 30h	**Tutorials:** 30h		**Practicals:** 0h	
Lecturer(s)	P. Bacchin, S. Galier, JC. Remigy				
Used sources	*1. Separation Process Engineering, Phillip C. Wankat 2006* *2. Separation Process Technology, Jimmy Humphrey, George Keller, 1997* *Chemical Engineering: Particle Technology and Separation Processes, J.M. Coulson, J.F. Richardson, J.R. Backhurst, J.H. Harker, 1996*				
Short description of course contents	1. Role of separation science in industry 2. Physico-chemical process involved in separation 3. Separating agents and associated technologies 4. E ciency and capacity of separation processes 5. Elements for process selection				
Competencies acquired by the student	Pilot the realization of tests in pilot units in order to optimize the performance of a separation process Carry out material and enthalpy balances to optimize the sizing of industrial installations implementing separation processes Identify the unit operation, the integration and implementation conditions, adapted to the separation of a mixture of several constituents				
System for assessment and evaluation	1. Assistance and participation in class and laboratory 2. Personal assignments 3. Oral Presentation 4. Examination				
Key words	Separation ; Adsorption, Donnan exclusion ; Extraction ; Absorption ; Distillation ; Membrane processes				

Course name	**Colloid and surface engineering**				
ECTS Credits	3	**Track/Semester**	MemENG - S1	**Type**	Mandatory
Course coordinator				**HEI**	UT3
Activities	**Lectures :** 15h	**Tutorials:** 15h		**Practicals:** 0h	
Lecturer(s)	Kevin Roger, Yannick Hallez				
Used sources	Russel, Saville and Schowalter, Colloidal Dispersions				
Short description of course contents	1. Thermodynamics of molecular mixtures, including polymer solutions 2. Self-assembly (surfactants, lipids, biomembranes) 3. Wetting and interfacial tensions 4. Colloidal interactions and stability 5. Electrokinetic phenomena (electrophoresis, electro-osmosis ...)				
Competencies acquired by the student	1. Understand why some liquids mix or rather phase separate from a molecular standpoint, use related thermodynamic parameters and phase diagrams. 2. Relate wetting and interfacial behavior to mixing thermodynamics and interaction parameters 3. Understand the molecular factors leading to self-assembly and its relevance for biomembranes 4. Evaluate colloidal interactions and their consequences on colloidal stability. 5. Understand and estimate the intensity of electrokinetic phenomena				
System for assessment and evaluation	Classical exam				
Key words	Polymer, colloids, interfaces, wetting, electrokinetics, stability				

Course name	**Life cycle analysis, Security, norm and risk**				
ECTS Credits	3	**Track/Semester**	MemENG - S1	**Type**	Mandatory
Course coordinator				**HEI**	UT3
Activities	**Lectures :** 15h	**Tutorials:** 15h		**Practicals:** 0h	
Lecturer(s)	Clémence Coetsier, Jean Christophe Remigy				
Used sources					
Short description of course contents	1. LCA methodology to assess the environmental impacts of products and processes 2. Know, find and understand AFNOR, ISO, CEI, ASTM or industry-specific standards. 3. Know the risks of the industries concerned 4. Know how to orient the design of products and services towards more environment-friendly solutions or to communicate environmental performance to customers				
Competencies acquired by the student	1. Analyze and evaluate the processing, production and processing units for materials and effluents in terms of safety and in response to the standards in force. 2. Evaluate the environmental impact of processes and products in terms of resources and life				
System for assessment and evaluation	Classical exam, group project				
Key words	Quality control, standards, lyfe cycle assessment				

Course name	**Bioseparation science**				
ECTS Credits	3	**Track/Semester**	MemENG - S1	**Type**	Mandatory
Course coordinator				**HEI**	UT3
Activities	**Lectures :** 15h	**Tutorials:** 15h		**Practicals:** 0h	
Lecturer(s)	Clémence Coetsier				
Used sources					
Short description of course contents	1. Implement and conduct bioprocesses taking into account contamination problems and the specificity of the metabolisms involved 2. Chemical engineering unit operations such as membrane filtration, centrifugation, adsorption, extraction and chromatography used as downstream processes in biotechnology				
Competencies acquired by the student	1. Evaluate and implement microorganisms in bioprocesses 2. Describe the microbial and enzymatic kinetics 3. Analyze microbial metabolism in a bioprocess to determine the yields and kinetics.				
System for assessment and evaluation	Classical exam, group project				
Key words	Microorganisms, Biotechnology, metabolisms, enzymatic kinetics, bioreactor				

Course name	**Project**				
ECTS Credits	6	**Track/Semester**	MemENG - S1	**Type**	Mandatory
Course coordinator				**HEI**	UT3
Activities	**Lectures :** 0h **Tutorials:** 0h **Practicals:** 60h				
Lecturer(s)	Jean-François Lahitte				
Used sources					
Short description of course contents	1. Know how to size a process, an installation or a device 2. Know and know how to use sources of information and documentation 3. Professional communication (cordial messages, anticipation, speed of response) 4. Respect good laboratory practices.				
Competencies acquired by the student	1. Answer to an industrial or scientific problematic using bibliograpy and experiments 2. Restitute an analytical and critical Synthesis of scientific information about a defined subject				
System for assessment and evaluation	Oral presentation + report				
Key words	Project management, communication, bibliography				

Course name	**Practical Labs**				
ECTS Credits	3	**Track/Semester**	MemENG - S1	**Type**	Mandatory
Course coordinator				**HEI**	UT3
Activities	**Lectures :** 0h	**Tutorials:**	0h	**Practicals:** 30h	
Lecturer(s)	Jean-François Lahitte				
Used sources					
Short description of course contents	Practical labs on the topics of transport phenomena, colloid and interface science, membrane fabrication and use.				
Competencies acquired by the student	1. Manipulate chemicals and measurement apparatus safely and precisely. 2. Deal with uncertainties associated to real systems. 3. Better understand concepts of other teaching units.				
System for assessment and evaluation	Reports				
Key words	Labs, measurements, analysis				

SEMESTER 2

Course name	**Membrane Processes**				
ECTS Credits	4	**Track/Semester**	MemENG - S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 2 h/week (28 h) **Tutorials:** 1 h/week (14 h) **Practicals:** 0h				
Lecturer(s)					
Used sources	Membrane Technology and Applications, 2nd Edition. Richard W. Baker,John Wiley & Sons, Ltd., 2004. Comprehensive Membrane Science and Engineering, E. Drioli, L.Giorno, Elsevier B.V., 2010. Basic Principles of Membrane Technology, 2nd Edition, M. Mulder, Kluwer Academic Publishers, 2003 Ion Exchange Membranes - Preparation, characterisation, modification and application. T. Sata, RSC Cambridge, 2004.				
Short description of course contents	The aim of this course is to make students familiar with the basic principles of the progressive membrane processes. They receive an increasing attention especially during the last few decades. After brief introduction focused on the basic membrane materials production and characterization the attention will be paid mainly to the separation processes. Both pressure as well as electric field driven processes are considered. Provided theoretical information will be documented on the examples of the industrial processes. In the final part of the course the issue of the fuel cells technology will be discussed as well. 1. Basic membrane types and their preparation 2. Characteristic properties of membranes, methods of testing 3. Membrane separation processes: classification according to the driving forces 4. Membrane separation processes based on the concentration gradient - osmosis, dialysis 5. Pressure membrane processes: reverse osmosis, ultrafiltration, microfiltration, nanofiltration 6. Electromembrane processes: electrodialysis, electrodeionization 7. Ion exchange membranes as solid electrolyte: "zero-gap" membrane electrolysis 8. Utilization of ion exchange membranes in fuel cells 9. Micro- and mezzo- porous membranes for gas and liquid separation 10. Mechanism of mass transfer in membranes 11. Utilization of membranes in separation technologies, industrial applications 12. Membrane reactors for homogeneous reactions 13. Membrane reactors for heterogeneous catalytic reactions 14. Membrane technologies in chemical industry, directions of development				
Competencies acquired by the student	Students will be able to: •understand the procedures of membrane preparation •understand the basic methods of membrane characterization •know industrial membrane applications				
System for assessment and evaluation	Assistance and participation in class and tutorials Solution of exercises Personal assigments Examination (written exam)				
Key words	Membrane processes; membranes; ultrafiltration; microfiltration; nanofiltration; reverse osmosis; dialysis; gas separation; fuel cells; electrodialysis; electrodeionization; mass transfer; mathematical modelling;				

Course name	**Process Design**				
ECTS Credits	5	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures :** 3 h/week (42 h) **Tutorials:** 1 h/week (14 h) **Practicals**: 0h				
Lecturer(s)	.				
Used sources	Process equipment product brochures (distributed by lecturer). Manuals of Aspen Plus software. R: R.Smith: Chemical Process: Design and Integration, John Wiley & Sons Inc, 2005, ISBN 9780471486817. A: McCabe, W. L , Smith, J. C., Harriott, P.: Unit operations of chemical engineering, Boston : McGraw-Hill, 2005, ISBN 007-124710-6				
Short description of course contents	The lectures are focused on tutorial of methodology of process design and development. During the exercises the students apply the universal simulation program Aspen Plus in development of simulation model of specific technology and design of apparatus. 1.On the process view of chemical production, know-how. 2.Selection of reactions' pathway, economical criterions, environmental protection. 3.Technological schema, mass and energy balance. 4.Application of design software. 5.Chemical reactors, membrane reactors and their models. 6.Pumps - characteristics and examples of selection. 7.Compression devices - characteristics, exhausters. 8.Filtration of suspensions, characteristics of filters and filtration membranes. 9.Energy exchange - heat exchangers and their characteristics. 10.Simulation of heat exchangers, design of optimal exchanger. 11.Rectification and pervaporation - the fundamentals, characteristics of columns. 12.Simulation of rectification and pervaporation. 13.Process control the regulation cycle, characteristics of regulators. 14.Examples of complex design of a concrete process.				
Competencies acquired by the student	Students will be able to: •define the suitable apparatuses and unit operations needed for industrial process implementation •define the key parameters of apparatuses, necessary for optimal functionality of process •apply the Aspen Plus software in simulation of chemical technologies				
System for assessment and evaluation	Assistance and participation in class and tutorials Solution of exercises Personal assigments Examination (written exam and defense of personal task/project)				
Key words	Process design; Mass and Energy balances; Unit operations; Equipment in chemical technologies;				

Course name	**Individual Project 2**				
ECTS Credits	7	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 0h	**Tutorials:** 0h		**Practicals:** 10 h/week (140 h)	
Lecturer(s)					
Used sources	according to instructions of work supervisor; guidelines for individual works				
Short description of course contents	The aim of the course is to introduce students to the systematic laboratory work. Students pass the characteristic work in various laboratories of the department and get to know with the basic experimental techniques of membrane characterization and membrane processes. 1. Permeability of membranes for gas separation 2. Selectivity of membranes for gas separation 3. Texture characteristic of membrane materials - ASAP, BET 4. Texture characteristic of membrane materials - mercury porosimetry 5. Ion selective membrane conductivity determination 6. Determination of the PEM fuel cell operational characteristics 7. Characterization of a PEM water-electrolyzer 8. Electrodialysis 9. Excursion: membrane preparation 10. Excursion: membrane process				
Competencies acquired by the student	Students will be able to: •conduct a given experiment •evaluate acquired data •prepare more extensive laboratory report				
System for assessment and evaluation	participation in practical works and excursions preparation for individual work reports				
Key words	practical work; Excursions; membrane characterization; Gas separation; PEM FC; PEM water electrolyzes; electrodialysis;				

Course name	**Applied Reaction Kinetics**				
ECTS Credits	5	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 2 h/week (28 h) **Tutorials:** 2 h/week (28 h) **Practicals:** 0h				
Lecturer(s)					
Used sources	Schmidt L D.: The Engineering of Chemical Reactions, Oxford University Press, 1998. H.S.Fogler,Elements of Chemical Rection Engineering,2nd Edition,Prentice Hall, 1992 J.G. Sanchéz Marcano and T.T. Tsotsis, Catalytic Membranes and Membrane Reactors WWW page of prof. H.Scott Fogler: http://www.engin.umich.edu/~cre/ web.vscht.cz/bernauem/vyuka/vyuka.html Matlab software manuals Macrocommands GAUSSIE (numerical integration), SIRK42E (numerical solution of system of ODE) in Excel.				
Short description of course contents	"The subject is focused on the analysis of behaviour of chemically reacting systems and design of chemical reactors. The students are introduced to basic concepts, mass and energy balances of reacting systems in steady and dynamic states. Further the students are acquainted with the analysis of heterogeneous reactions both catalytic and non catalytic together with chemical reactor models used in heterogeneous reaction applications. The important part of subject is the design of chemical reactor based on laboratory kinetic data. 1.Reaction rate definition. Elementary reactions. Systems of chemical reaction. 2.Balances in isothermal reacting systems. Stoichiometry, conversion. 3.Basic models of chemical reactors for homogeneous systems. 4.Kinetic parameters estimation from isothermal kinetic data. 5.Energy balance in reacting systems. Models of homogeneous non isothermal reactors. 6.Dynamic behaviour of non isothermal homogeneous reactors. 7.Heterogeneous catalytic reactions in a gas phase. 8.Mass and heat transfer in porous catalyst. 9.Fixed bed reactor. 10.Simultaneous separations and reactions. 11.Catalytic membrane separation processes and reactors. 12.Pervaporation membrane reactors 13.Membrane bioreactors. 14.Industrial reactor design."				
Competencies acquired by the student	Develop mass and energy balances of reacting systems. Describe the behavior of chemical reactors on the basis of mathematical models. Create the model of static and dynamic behavior of chemical reactors on the basis of numerical solution of mathematical m				
System for assessment and evaluation	Assistance and participation in class and tutorials Solution of exercises Personal assigments Examination (written exam and defense of personal task/project)				
Key words	Reactor; kinetics; catalysis; energy balance; mass balance; mathematical modelling;				

Course name	**HR Management Systems**				
ECTS Credits	6	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 2 h/week (28 h) **Tutorials:** 2 h/week (28 h) **Practicals:** 2 h/week (28 h)				
Lecturer(s)					
Used sources	Human Resource Management (2016). University of Minnesota Libraries Publishing, 459 p. https://open.lib.umn.edu/humanresourcemanagement/ Armstrong, M. and Taylor, S. (2014). Armstrong´s Handbook of Human Resource Management Practice. 13ed. KoganPage, 440 p. https://www.academia.edu/32280546/ARMSTRONGS_HANDBOOK_OF_HUMAN_RESOURCE_MANAGEMENT_PRACTICE_i				
Short description of course contents	The course deals with the topics of human resource management, which are an extension of basic concepts and relationships.These are topics that are either discussed in academia and among practitioners, or belong to modern trends in the management of organizations. Includes HR business partnering, personnel / HR practices applied for stabilization employees and work motivation, incentive wage forms, management of human resources diversity, relations with trade unions, trends in occupational safety and health and international human resources management. 1. Labor markets, aging population, and migration 2. HR business partnering 3. Employer branding 4. Employee motivation and retention 5. Talent management 6. Incentives reward management 7. Wage/salary surveys and differences. 8. Collective labor relations 9. HR diversity management 10. Toxic organization and the quality of work-life 11. International HRM 12. International HRM 13. Trends in occupational health and safety 14. Trends in HRM				
Competencies acquired by the student	Students will be able to: Analyze the benefits and downsides of human resource management practices Understand trends in human management in organizations Use selected techniques for stimulation and objective evaluation of subordinates				
System for assessment and evaluation	Assistance and participation in class, tutorials and practicals Team seminar work (team 2-3 students) Written-exam 14 open questions, 60 minutes				
Key words	Human Resource Management, Employee motivation and retention, HR diversity management				

Course name	**Valorisation, Commercialisation and Entrepreneurship available in MemENG (Could be shared by 2-3 tracks S2)à it depends on the content of semester 1 at UNIZAR**				
ECTS Credits	3	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 2 h/week (28 h) **Tutorials:** 1 h/week (14 h) **Practicals:** 0h				
Lecturer(s)					

Course name	**Valorisation, Commercialisation and Entrepreneurship available in MemENG (Could be shared by 2-3 tracks S2)à it depends on the content of semester 1 at UNIZAR**				
ECTS Credits	3	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Used sources	EBERT, R. J.; GRIFFIN, R. W. Business Essentials. 8th ed., New York : Prentice Hall, 2010. 336 s., ISBN 978-0137053490. FANNIN, R. A. Startup Asia: Top Strategies for Cashing in on Asia's Innovation Boom. Singapore : John Wiley & Sons (Asia), 2011. 256 s., ISBN 978-0470829905. A:MIAN, S. A. Science and Technology Based Regional Entrepreneurship: Global Experience in Policy and Program Development. Cheltenham : Edward Elgar Pub., 2011. 488 s., ISBN 978-1847203908. COOKE, P.; ASHEIM, B.; BOSCHMA, R.; MARTIN, R.; SCHWARTZ, D.; T-DTLING, F. Handbook of Regional Innovation and Growth. Cheltenham : Edward Elgar Pub., 2011. 648 s., ISBN 978-1848444171. ROBBINS, S. P.; COULTER, M. Management. 10th ed., Englewood Cliffs : Prentice-Hall, 2008. 592 p., ISBN978-0-13-209071-1. WEBER, L. Don't Let 'em Treat You Like a Girl: A Woman's Guide to Leadership Success. 3rd ed., North Charleston : RidgeRunner Publishing, 2011. 199 s., ISBN 978-1-59109-981-9.				
Short description of course contents	The aim of the theme is to inform students about the most important topics in carrying business and manage the companies dealing with new knowledge, on the boundary among science and industrial practice - namely spin-off companies. It contains also the primary information concerning management as a whole, its system, theory and methods. 1.Management - basic issues, function and structure; manager and his position, levels. Management and entrepreneurship. Management history overview. 2.Innovation and its implementation - specific issues in industrial implementation of newly developed methods, technologies and products. Specific needs in development, marketing, production, financing and selling. 3.Main processes in management: planning - its use and importance, planning process, structure of the plans. How to establish and maintain plans, effectiveness of planning, planning, probability and fortuity. 4.Main processes in management: organization - structures in organization and architecture of organizations, impact of organization, flexible issues, working place, description of work, factors influencing work flow. 5.Main processes in management: motivation - system of motivation and stimulation, how to motivate people, selfmotivation, psychology of motivation, social base of motivation. 6.Main processes in management: decision making - processes of decision making, issues of decision making, risk and uncertainty, models and methods of decision making. 7.Main processes in management: checking and control - aim and structure of the checking and control, weak points of controlling, criteria and their setting, modern methods. 8.Main processes in management: communication - partners in communication, coding. Information in management - value of information, information as a competitive advantage. Managerial information systems - principles, utilization, decision making support, expert systems, loss of information, feedback, forms of communication, internal and external communication. 9.Leadership - leadership as an ability to lead people, as a specific form of management. Positive and negative tactics. How to deal with specific people. Ladies in management. 10.International management - specific issues, working in international companies, how to deal with cultural diversity, differences in customs, team management in international milieu. Team work - group and team, main team positions, team development, effectiveness of teamwork. How to prepare, manage and use the meetings. 11.New enterprise creation and development. Financial prerequisites and financing of the new enterprise 12.Profile and manager's personality - basic competencies of managers, general principles and style of manager's work, responsibility, attitude of manager towards his employees, time management, priorities, prevention of collapse. Organization's identity - components, image and its change. Corporate culture / sources, surrounding, ethics. How to change the corporate culture. 13.Strategic management - strategy, its aim and importance. How to develop a strategy. Strategic concepts utilization. Strategy evaluation. System of strategic management."				

Course name	**Valorisation, Commercialisation and Entrepreneurship available in MemENG (Could be shared by 2-3 tracks S2)à it depends on the content of semester 1 at UNIZAR**				
ECTS Credits	3	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Competencies acquired by the student	Students will be able to: understand to the specific issues in industrial implementation of newly developed methods, technologies and products apply the knowledge of main processes in management (organization, motivation,control, communication, planning and strategy development) understand to the specific issues related to the creation and development of new enterprise				
System for assessment and evaluation	Assistance and participation in class and tutorials Personal assigments Examination (oral exam and defense of project)				
Key words	spin-off; management; decision making; strategic concept; management communication; work flow; leadership				

Membrane Technologies and Project Management MemTECH (30 ECTS)

SEMESTER 1

Course name	**Organizations and their human resource management**				
ECTS Credits	4.5	**Track/Semester**	MemTECH - S1	**Type**	Mandatory
Course coordinator				**HEI**	Universidad de Zaragoza
Activities	**Lectures :** 35h	**Tutorials:** 4h		**Practicals:** 14h	
Lecturer(s)					
Used sources					
Short description of course contents	SECTION I. THE HUMAN RESOURCE MANAGEMENT AND ENVIRONMENTAL FACTORS The human resource management: concept, functions and functional organization Strategic human resource management: concept, strategies and environment Environment I: Legal framework and labor market. Work organization and work risk prevention Environment II: Training Framework (human capital, social capital, training and education system) SECTION II. FUNCTIONS OF HUMAN RESOURCE MANAGEMENT Human resources planning, job analysis and job evaluation The employment function (I): additive employment practices The employment function (II): subtractive employment practices Maintaining human resources (I): performance assessment Maintaining human resources (II): wage policy The development of human resources: training and career management.				
Competencies acquired by the student	-Possess and understand knowledge that provides basis or opportunity to be original in the development and / or application of ideas, often in a research context. -To be able to exercise functions of general management, technical management and management of R + D + i projects in plants, companies and technology centers. -Know how to communicate the conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way. -Capacities for work organization and human resource management. Knowledge about occupational risk prevention. -Knowledge and skills to organize and direct companies -Knowledge of commercial and labor law				
System for assessment and evaluation	Carrying out three laboratory practices, in which students will apply the knowledge acquired in theory classes to solve a series of proposed problems; for those who, given its extension, resolution method, need to use the network or complexity, the computer is a necessary tool. Students will deliver the solutions obtained at the end of each practice. These practices will account for 15% of the final grade Preparation and subsequent oral presentation of a critical analysis of a reading assigned by the teacher. In this analysis, students will carry out a practical application of the knowledge acquired during the course in a specific business environment. This activity will account for 15%. Questionnaires about the collective activities (readings, audiovisuals, debates, etc.) that take place during the course. These questionnaires will represent 10% of the final grade. These collective activities will be proposed by the teachers and by the students, in order to exemplify the theoretical knowledge and to delve into current practical aspects of HR. A final written test on the contents developed in the theory classes and in the problem sessions and resolution of cases that will account for 60% of the final grade				
Key words	Human resource management, human capital, social capital, job analysis and job evaluation, training and career management.				

Course name	**Industrial and R&D project management**				
ECTS Credits	6	**Track/Semester**	MemTECH - S1	**Type**	Mandatory
Course coordinator				**HEI**	Universidad de Zaragoza
Activities	**Lectures :** 30h	**Tutorials:** 4h		**Practicals:** 95h	
Lecturer(s)					
Used sources					
Short description of course contents	Introduction and project life cycle Project scope and definition Project management in research projects Time management Cost management Risk management Procurement management Health and safety in project management Human resources in project management Agile project management Case Studies Case 1. Definition and scope Case 2. Microsoft Project Case 3. Stochastic planning Case 4. Project control through Earned Value Management Case 5. Project risk management Case 6. Human resources in project management Case 7. Integration Case 8. Project Simulation Game Practice sessions Session 1. Microsoft Project Session 2. Stochastic planning				
Competencies acquired by the student	Knowledge and skills for integrated project management. Ability to manage Research, Development and Technological Innovation. To be able to define the scope of a project, identifying the deliverables and tasks to be carried out to meet its objectives, as well as managing its changes. To be able to plan and control project deadlines and costs, estimating the duration of activities and assigning the necessary resources, all using techniques such as the Gantt chart, PERT, critical chain and earned value analysis. To be able to select, in view of the need to supply a product or service for a project, the most appropriate type of contract. To be able to identify, evaluate and manage the most important risks of a project, proposing response strategies to them to minimize their impact on the project objectives. To be able to use motivation, leadership and negotiation techniques for the management of project teams. Understanding the characteristics of R & D & i project management and will be able to manage the complexity and uncertainty associated with them.				
System for assessment and evaluation	Global assessment test in the exam period which will consist of the following parts: - Individual test. It is intended to evaluate if the student has understood the basic concepts of the course, master the terminology and is able to apply these concepts to the understanding of small exercises or problems. The test will be 30% of the student's grade. -Practical work(s). Throughout the course one or more practical works will be carried out, which must be delivered and presented on the day the global assessment test takes place. The quality of the documentation presented by the work team as well as the defense thereof will be valued, and will account for 70% of the student's grade. It will be mandatory to carry out these practical work(s) as a group. For the evaluation of these practical works the professors will be able to propose systems of evaluation by peers, in which the own students will evaluate the performance of their teammates during the accomplishment of the works and / or practical cases and that will serve to determine the qualification of each student in the practical part.				
Key words	Project management, project life cycle, Health and safety, human resources				

Course name	**Economy and Industrial Organization**				
ECTS Credits	6	**Track/Semester**	MemTECH - S1	**Type**	Mandatory
Course coordinator				**HEI**	Universidad de Zaragoza
Activities	**Lectures :** 40h	**Tutorials:** 10h		**Practicals:** 20h	
Lecturer(s)					
Used sources					
Short description of course contents	INTRODUCTION Topic 1: The nature of strategic management SECTION I. STRATEGIC ANALYSIS Topic 2: The objectives and the values of the firm Topic 3: Environment analysis Topic 4: Internal analysis SECTION II. STRATEGY FORMULATION Topic 5: Strategy and competitive advantage Topic 6: Innovation management and strategy Topic 7: Directions and methods of firm development Topic 8: Internationalization SECTION III: STRATEGY IMPLEMENTATION Topic 9: Strategy evaluation and implementation.				
Competencies acquired by the student	To lead technically and economically management of projects, facilities, plants, companies and technology centers in the field of chemical engineering and related industrial sectors Capacity for analysis and synthesis for the continuous progress of products, processes, systems and services using criteria of safety, economic viability, quality and environmental management. Lead and define multidisciplinary teams capable of solving technical changes and managerial needs in national and international contexts. Direct and organize companies, as well as production and service systems, applying knowledge and skills of industrial organization, business strategy, planning and logistics, commercial and labor legislation, financial and cost accounting. Manage Research, Development and Technological Innovation, attending to the transfer of technology and property and patent rights. Adapt to structural changes in society motivated by factors or phenomena of an economic, energy or natural nature, to solve the derived problems and provide technological solutions with a high commitment to sustainability.				
System for assessment and evaluation	Acitivty 1. Preparation and subsequent presentation of a supervised group work related to the contents of the syllabus. It will consist of the analysis of a company and the strategy followed by it. In this work, students will carry out a practical application of the knowledge acquired during the course. This work will represent 30% of the final grade. Activity 2. Carrying out practical work, including deliverable exercises, analysis of individual cases or participation in discussions of the content of the subject, where students will apply the knowledge acquired in the theory sessions to a series of proposed situations. Said activities may be carried out during the course sessions or the teaching staff will propose deadlines for their preparation and / or delivery. Said practical activities will account for 20% of the final grade. Activity 3. A final written test on the contents developed in the theory sessions and in the problem and practical sessions that will account for 50% of the final grade. The exam will consist of critical commentary on texts related to relevant business situations in the context of Strategic Management. In order to pass the subject by ordinary evaluation, the student must obtain a score of at least 5 among the three evaluation activities.				
Key words	Strategic management, competitive advantage, innovation management, internationalization,strategy evaluation and implementation				

Course name	Ecodesign and life cycle analysis				
ECTS Credits	3	**Track/Semester**	MemTECH - S1	**Type**	Mandatory
Course coordinator				**HEI**	Universidad de Zaragoza
Activities	**Lectures :** 15h	**Tutorials:** 4h		**Practicals:** 15h	
Lecturer(s)					
Used sources					
Short description of course contents	Topic 1. Ecodesign concept: Contribution to sustainability through product design. Legal requirements in the eco-design of product. Topic 2. Ecodesign methodology. Tools. Topic 3. Life cycle analysis (LCA): Methodology, databases, tools. Implementation of the LCA for eco-design. Topic 4. Product environmental statement: Self-environmental statement and eco-labeling.				
Competencies acquired by the student	Carry out appropriate research, undertake the design and direct the development of engineering solutions, in new or little-known environments, relating creativity, originality, innovation and technology transfer. Ability for analysis and synthesis for the continuous progress of products, processes, systems and services using criteria of safety, economic viability, quality and environmental management. Integrate knowledge and face the complexity of making judgments and decision-making, based on incomplete or limited information, which include reflections on the social and ethical responsibilities of professional practice. Direct and manage the organization of work and human resources applying criteria of industrial safety, quality management, prevention of occupational risks, sustainability, and environmental management Adapt to structural changes in society motivated by factors or phenomena of an economic, energy or natural nature, to solve the derived problems and provide technological solutions with a high commitment to sustainability				
System for assessment and evaluation	1. Making oral presentations (P). 2. Resolution of practical cases, examples raised in seminar classes (CP). 3.- Carrying out an academic work. In addition to the content and the expected result, the reasoning carried out and formal aspects will be valued, as well as the oral presentation (E). 4. Direct observation about active participation in classes (O). The evaluation is global and the grade for the course will be calculated according to the following formula: Grade = 0,3· P + 0,2CP + 0,4· E + 0,1· O				
Key words	Sustainability, Life cycle analysis (LCA) eco-design and eco-labelling				

Course name	**Team project**				
ECTS Credits	7.5	**Track/Semester**	MemTECH - S1	**Type**	Mandatory
Course coordinator				**HEI**	Universidad de Zaragoza
Activities	**Lectures :** 4h	**Tutorials:** 12h		**Practicals:** 0h	
Lecturer(s)					
Used sources					
Short description of course contents	In this subject the student will deal with the management of a collaborative project based on membrane technology together with students from track MemENG. The students will be divided in groUT3 of 4 (with 2 students from each track), each student will take a role for a successful development of the project. The project aims to put together the technical knowledge about membrane technology acquired by the students at UT3, and the project management knowledge from UNIZAR students. The first two weeks consists of 2 sessions by videoconference with teachers from UT3 and UNIZAR, with all the students, to establish the main goals and deliverables of the projects and definition of teams. Then the students will work together for a period of 5 weeks,to build up the project. To communicate and share information the students will use computer tools such as Microsoft Teams, information on cloud, etc.. A midterm session, will be devoted to present the status of the projects. During the assignment the students will be tutorized and have regular meetings every one or two weeks for discussion.				
Competencies acquired by the student	To lead technically and economically management of projects, Lead and define multidisciplinary teams capable of solving technical changes and managerial needs in national and international contexts. Manage Research, Development and Technological Innovation, attending to the transfer of technology and property and patent rights. Possess and understand knowledge that provides basis or opportunity to be original in the development and / or application of ideas, often in a research context. To be able to exercise functions of general management, technical management and management of R + D + i projects. Know how to communicate the conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way. Capacities for work organization and human resource management				
System for assessment and evaluation	The evaluation will be through a written project and oral presentation at the end of the assignment.				
Key words	Membrane technology, innovation mamagement, internationalization, project development				

SEMESTER 2

Course name	**Membrane Processes**				
ECTS Credits	4	**Track/Semester**	MemENG - S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 2 h/week (28 h) **Tutorials:** 1 h/week (14 h) **Practicals:** 0h				
Lecturer(s)					
Used sources	Membrane Technology and Applications, 2nd Edition. Richard W. Baker,John Wiley & Sons, Ltd., 2004. Comprehensive Membrane Science and Engineering, E. Drioli, L.Giorno, Elsevier B.V., 2010. Basic Principles of Membrane Technology, 2nd Edition, M. Mulder, Kluwer Academic Publishers, 2003 Ion Exchange Membranes - Preparation, characterisation, modification and application. T. Sata, RSC Cambridge, 2004.				
Short description of course contents	The aim of this course is to make students familiar with the basic principles of the progressive membrane processes. They receive an increasing attention especially during the last few decades. After brief introduction focused on the basic membrane materials production and characterization the attention will be paid mainly to the separation processes. Both pressure as well as electric field driven processes are considered. Provided theoretical information will be documented on the examples of the industrial processes. In the final part of the course the issue of the fuel cells technology will be discussed as well. 1. Basic membrane types and their preparation 2. Characteristic properties of membranes, methods of testing 3. Membrane separation processes: classification according to the driving forces 4. Membrane separation processes based on the concentration gradient - osmosis, dialysis 5. Pressure membrane processes: reverse osmosis, ultrafiltration, microfiltration, nanofiltration 6. Electromembrane processes: electrodialysis, electrodeionization 7. Ion exchange membranes as solid electrolyte: "zero-gap" membrane electrolysis 8. Utilization of ion exchange membranes in fuel cells 9. Micro- and mezzo- porous membranes for gas and liquid separation 10. Mechanism of mass transfer in membranes 11. Utilization of membranes in separation technologies, industrial applications 12. Membrane reactors for homogeneous reactions 13. Membrane reactors for heterogeneous catalytic reactions 14. Membrane technologies in chemical industry, directions of development				
Competencies acquired by the student	Students will be able to: •understand the procedures of membrane preparation •understand the basic methods of membrane characterization •know industrial membrane applications				
System for assessment and evaluation	Assistance and participation in class and tutorials Solution of exercises Personal assigments Examination (written exam)				
Key words	Membrane processes; membranes; ultrafiltration; microfiltration; nanofiltration; reverse osmosis; dialysis; gas separation; fuel cells; electrodialysis; electrodeionization; mass transfer; mathematical modelling;				

Course name	**Process Design**				
ECTS Credits	5	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 3 h/week (42 h) **Tutorials:** 1 h/week (14 h) **Practicals:** 0h				
Lecturer(s)	.				
Used sources	Process equipment product brochures (distributed by lecturer). Manuals of Aspen Plus software. R: R.Smith: Chemical Process: Design and Integration, John Wiley & Sons Inc, 2005, ISBN 9780471486817. A: McCabe, W. L , Smith, J. C., Harriott, P.: Unit operations of chemical engineering, Boston : McGraw-Hill, 2005, ISBN 007-124710-6				
Short description of course contents	The lectures are focused on tutorial of methodology of process design and development. During the exercises the students apply the universal simulation program Aspen Plus in development of simulation model of specific technology and design of apparatus. 1.On the process view of chemical production, know-how. 2.Selection of reactions' pathway, economical criterions, environmental protection. 3.Technological schema, mass and energy balance. 4.Application of design software. 5.Chemical reactors, membrane reactors and their models. 6.Pumps - characteristics and examples of selection. 7.Compression devices - characteristics, exhausters. 8.Filtration of suspensions, characteristics of filters and filtration membranes. 9.Energy exchange - heat exchangers and their characteristics. 10.Simulation of heat exchangers, design of optimal exchanger. 11.Rectification and pervaporation - the fundamentals, characteristics of columns. 12.Simulation of rectification and pervaporation. 13.Process control the regulation cycle, characteristics of regulators. 14.Examples of complex design of a concrete process.				
Competencies acquired by the student	Students will be able to: •define the suitable apparatuses and unit operations needed for industrial process implementation •define the key parameters of apparatuses, necessary for optimal functionality of process •apply the Aspen Plus software in simulation of chemical technologies				
System for assessment and evaluation	Assistance and participation in class and tutorials Solution of exercises Personal assigments Examination (written exam and defense of personal task/project)				
Key words	Process design; Mass and Energy balances; Unit operations; Equipment in chemical technologies;				

Course name	**Individual Project 2**				
ECTS Credits	7	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 0h	**Tutorials:** 0h		**Practicals:** 10 h/week (140 h)	
Lecturer(s)					
Used sources	according to instructions of work supervisor; guidelines for individual works				
Short description of course contents	The aim of the course is to introduce students to the systematic laboratory work. Students pass the characteristic work in various laboratories of the department and get to know with the basic experimental techniques of membrane characterization and membrane processes. 1. Permeability of membranes for gas separation 2. Selectivity of membranes for gas separation 3. Texture characteristic of membrane materials - ASAP, BET 4. Texture characteristic of membrane materials - mercury porosimetry 5. Ion selective membrane conductivity determination 6. Determination of the PEM fuel cell operational characteristics 7. Characterization of a PEM water-electrolyzer 8. Electrodialysis 9. Excursion: membrane preparation 10. Excursion: membrane process				
Competencies acquired by the student	Students will be able to: •conduct a given experiment •evaluate acquired data •prepare more extensive laboratory report				
System for assessment and evaluation	participation in practical works and excursions preparation for individual work reports				
Key words	practical work; Excursions; membrane characterization; Gas separation; PEM FC; PEM water electrolyzes; electrodialysis;				

Course name	**Applied Reaction Kinetics**				
ECTS Credits	5	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 2 h/week (28 h) **Tutorials:** 2 h/week (28 h) **Practicals:** 0h				
Lecturer(s)					
Used sources	Schmidt L D.: The Engineering of Chemical Reactions, Oxford University Press, 1998. H.S.Fogler,Elements of Chemical Rection Engineering,2nd Edition,Prentice Hall, 1992 J.G. Sanchéz Marcano and T.T. Tsotsis, Catalytic Membranes and Membrane Reactors WWW page of prof. H.Scott Fogler: http://www.engin.umich.edu/~cre/ web.vscht.cz/bernauem/vyuka/vyuka.html Matlab software manuals Macrocommands GAUSSIE (numerical integration), SIRK42E (numerical solution of system of ODE) in Excel.				
Short description of course contents	"The subject is focused on the analysis of behaviour of chemically reacting systems and design of chemical reactors. The students are introduced to basic concepts, mass and energy balances of reacting systems in steady and dynamic states. Further the students are acquainted with the analysis of heterogeneous reactions both catalytic and non catalytic together with chemical reactor models used in heterogeneous reaction applications. The important part of subject is the design of chemical reactor based on laboratory kinetic data. 1.Reaction rate definition. Elementary reactions. Systems of chemical reaction. 2.Balances in isothermal reacting systems. Stoichiometry, conversion. 3.Basic models of chemical reactors for homogeneous systems. 4.Kinetic parameters estimation from isothermal kinetic data. 5.Energy balance in reacting systems. Models of homogeneous non isothermal reactors. 6.Dynamic behaviour of non isothermal homogeneous reactors. 7.Heterogeneous catalytic reactions in a gas phase. 8.Mass and heat transfer in porous catalyst. 9.Fixed bed reactor. 10.Simultaneous separations and reactions. 11.Catalytic membrane separation processes and reactors. 12.Pervaporation membrane reactors 13.Membrane bioreactors. 14.Industrial reactor design."				
Competencies acquired by the student	Develop mass and energy balances of reacting systems. Describe the behavior of chemical reactors on the basis of mathematical models. Create the model of static and dynamic behavior of chemical reactors on the basis of numerical solution of mathematical m				
System for assessment and evaluation	Assistance and participation in class and tutorials Solution of exercises Personal assigments Examination (written exam and defense of personal task/project)				
Key words	Reactor; kinetics; catalysis; energy balance; mass balance; mathematical modelling;				

Course name	**HR Management Systems**				
ECTS Credits	6	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 2 h/week (28 h) **Tutorials:** 2 h/week (28 h) **Practicals:** 2 h/week (28 h)				
Lecturer(s)					
Used sources	Human Resource Management (2016). University of Minnesota Libraries Publishing, 459 p. https://open.lib.umn.edu/humanresourcemanagement/ Armstrong, M. and Taylor, S. (2014). Armstrong´s Handbook of Human Resource Management Practice. 13ed. KoganPage, 440 p. https://www.academia.edu/32280546/ARMSTRONGS_HANDBOOK_OF_HUMAN_RESOURCE_MANAGEMENT_PRACTICE_i				
Short description of course contents	The course deals with the topics of human resource management, which are an extension of basic concepts and relationships.These are topics that are either discussed in academia and among practitioners, or belong to modern trends in the management of organizations. Includes HR business partnering, personnel / HR practices applied for stabilization employees and work motivation, incentive wage forms, management of human resources diversity, relations with trade unions, trends in occupational safety and health and international human resources management. 1. Labor markets, aging population, and migration 2. HR business partnering 3. Employer branding 4. Employee motivation and retention 5. Talent management 6. Incentives reward management 7. Wage/salary surveys and differences. 8. Collective labor relations 9. HR diversity management 10. Toxic organization and the quality of work-life 11. International HRM 12. International HRM 13. Trends in occupational health and safety 14. Trends in HRM				
Competencies acquired by the student	Students will be able to: Analyze the benefits and downsides of human resource management practices Understand trends in human management in organizations Use selected techniques for stimulation and objective evaluation of subordinates				
System for assessment and evaluation	Assistance and participation in class, tutorials and practicals Team seminar work (team 2-3 students) Written-exam 14 open questions, 60 minutes				
Key words	Human Resource Management, Employee motivation and retention, HR diversity management				

Course name	**Valorisation, Commercialisation and Entrepreneurship available in MemENG (Could be shared by 2-3 tracks S2)à it depends on the content of semester 1 at UNIZAR**				
ECTS Credits	3	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Activities	**Lectures** : 2 h/week (28 h) **Tutorials:** 1 h/week (14 h) **Practicals:** 0h				
Lecturer(s)					
Used sources	EBERT, R. J.; GRIFFIN, R. W. Business Essentials. 8th ed., New York : Prentice Hall, 2010. 336 s., ISBN 978-0137053490. FANNIN, R. A. Startup Asia: Top Strategies for Cashing in on Asia's Innovation Boom. Singapore : John Wiley & Sons (Asia), 2011. 256 s., ISBN 978-0470829905. A:MIAN, S. A. Science and Technology Based Regional Entrepreneurship: Global Experience in Policy and Program Development. Cheltenham : Edward Elgar Pub., 2011. 488 s., ISBN 978-1847203908. COOKE, P.; ASHEIM, B.; BOSCHMA, R.; MARTIN, R.; SCHWARTZ, D.; T-DTLING, F. Handbook of Regional Innovation and Growth. Cheltenham : Edward Elgar Pub., 2011. 648 s., ISBN 978-1848444171. ROBBINS, S. P.; COULTER, M. Management. 10th ed., Englewood Cliffs : Prentice-Hall, 2008. 592 p., ISBN978-0-13-209071-1. WEBER, L. Don't Let 'em Treat You Like a Girl: A Woman's Guide to Leadership Success. 3rd ed., North Charleston : RidgeRunner Publishing, 2011. 199 s., ISBN 978-1-59109-981-9.				

Course name	**Valorisation, Commercialisation and Entrepreneurship available in MemENG (Could be shared by 2-3 tracks S2)à it depends on the content of semester 1 at UNIZAR**				
ECTS Credits	3	**Track/Semester**	MemENG – S2	**Type**	Mandatory
Course coordinator				**HEI**	UCTP
Short description of course contents	The aim of the theme is to inform students about the most important topics in carrying business and manage the companies dealing with new knowledge, on the boundary among science and industrial practice - namely spin-off companies. It contains also the primary information concerning management as a whole, its system, theory and methods. 1.Management - basic issues, function and structure; manager and his position, levels. Management and entrepreneurship. Management history overview. 2.Innovation and its implementation - specific issues in industrial implementation of newly developed methods, technologies and products. Specific needs in development, marketing, production, financing and selling. 3.Main processes in management: planning - its use and importance, planning process, structure of the plans. How to establish and maintain plans, effectiveness of planning, planning, probability and fortuity. 4.Main processes in management: organization - structures in organization and architecture of organizations, impact of organization, flexible issues, working place, description of work, factors influencing work flow. 5.Main processes in management: motivation - system of motivation and stimulation, how to motivate people, selfmotivation, psychology of motivation, social base of motivation. 6.Main processes in management: decision making - processes of decision making, issues of decision making, risk and uncertainty, models and methods of decision making. 7.Main processes in management: checking and control - aim and structure of the checking and control, weak points of controlling, criteria and their setting, modern methods. 8.Main processes in management: communication - partners in communication, coding. Information in management - value of information, information as a competitive advantage. Managerial information systems - principles, utilization, decision making support, expert systems, loss of information, feedback, forms of communication, internal and external communication. 9.Leadership - leadership as an ability to lead people, as a specific form of management. Positive and negative tactics. How to deal with specific people. Ladies in management. 10.International management - specific issues, working in international companies, how to deal with cultural diversity, differences in customs, team management in international milieu. Team work - group and team, main team positions, team development, effectiveness of teamwork. How to prepare, manage and use the meetings. 11.New enterprise creation and development. Financial prerequisites and financing of the new enterprise 12.Profile and manager's personality - basic competencies of managers, general principles and style of manager's work, responsibility, attitude of manager towards his employees, time management, priorities, prevention of collapse. Organization's identity - components, image and its change. Corporate culture / sources, surrounding, ethics. How to change the corporate culture. 13.Strategic management - strategy, its aim and importance. How to develop a strategy. Strategic concepts utilization. Strategy evaluation. System of strategic management."				
Competencies acquired by the student	Students will be able to: understand to the specific issues in industrial implementation of newly developed methods, technologies and products apply the knowledge of main processes in management (organization, motivation,control, communication, planning and strategy development) understand to the specific issues related to the creation and development of new enterprise				
System for assessment and evaluation	Assistance and participation in class and tutorials Personal assigments Examination (oral exam and defense of project)				
Key words	spin-off; management; decision making; strategic concept; management communication; work flow; leadership				

S1- Course- Entrepreneurship and Innovation

Course name	**Entrepreneurship and Innovation (Online Course)**				
ECTS Credits	3	**Track/Semester**	MemMAT - S1 MemENG – S1 MemTECH –S1	**Type**	External contribution
Course coordinator	Fernanda Llussá			**HEI**	NOVA
Lecturer(s)	Fernanda Llussá				
Activities	**Lectures : 14h** **Tutorials: 14h** **Practicals:** 0h				
Used sources	[SA] Spinelli, S. and Adams, R., 2011, New Venture Creation: Entrepreneurship for the 21st Century, McGraw-Hill/Irwin. [BDN] Byers, T., Dorf, R. and Nelson, A., 2010, Technology Ventures: From Idea to Enterprise, McGraw- Hill Science/Engineering/Math. [HPS] Hisrich, R., Peters, M. and Shepherd, D., 2012, Entrepreneurship, McGraw-Hill/Irwin. [B] Bhide, A., 1996, The Questions Every Entrepreneur Must Answer, Harvard Business Review. [D06] Drucker, P., 2006, Innovation and Entrepreneurship, Harper Business. [D02] Drucker, P., 2002, The Discipline of Innovation, Harvard Business Review. [SSRB] Shalman, W., Stevenson, H., Roberts, M. and Bhide, A., 1999, The Entrepreneurial Venture, Harvard Business Review Press. [KS] Katzenbach, J. and Smith, D., 1993, "The Discipline of Teams", Harvard Business Review.				
Short description of course contents	This course covers general topics in entrepreneurship, stimulating a mindset and live attitude towards innovation and entrepreneurial activity. In particular, it explores the developments of technology ideas interconnected with market validation, encompassing the contents for delivering an effective Elevator Pitch and a convincing Business Plan for a selected business idea.				
Competencies acquired by the student	1. Foster entrepreneurial mindset and deepen student´s knowledge in the field of entrepreneurship; 2. Development of an ecosystem thinking of sustainability from innovation; 3. Expose students to innovations in the field of membrane engineering; 4. Develop teamwork skills and global innovation leadership skills 5. Develop written and oral skills				
System for assessment and evaluation	Students are going to be divided in teams of 3 people. Each team has to search a membranes-based business idea, to be developed and evaluated throughout the course. This work and evaluation involves a *midterm presentation*, a 1 minute *YouTube video* and a *final evaluation*. The final evaluation is divided into an oral part, the elevator pitch (5 minutes), and a report, the business plan (15 pages content). They will count toward the grade as follows: Midterm presentation 20% 1 min YouTube video 15 % Final Presentation - Elevator pitch 30% Business plan Report 35%				
Key words	Innovation, entrepreneurship, technology				

Energy

Course name	**Advanced colloids & Interfaces**				
ECTS Credits	5	**Track/Semester**	Energy - S3	**Type**	Mandatory
Course coordinator		Wood		**HEI**	University of Twente
Activities	**Lectures :** 16h	**Tutorials:** 0h		**Practicals:** 0h	
Lecturer(s)	Wood, Duits				
Used sources	Handouts and other literature will be provided during the course				
Short description of course contents	Description of colloids, surfaces and interfaces. All kinds of interfaces between different phases are treated. Thermodynamic descriptions of these interfaces are deduced. Several techniques for characterizing interfaces are discussed. During contact hours, the contents of will be presented and discussed, and exercises will be made and discussed. For each topic, a case assignment will be offered. Topics include: • Lifshitz-van der Waals Interactions • Polar/Acid-Base Interactions • Wetting and Contact Angles • Electrostatics • DLVO and XDLVO interaction • Electrokinetic Phenomena • Electrostatic and Polymeric Stabilization of Colloids • Colloidal Phenomena (Marangoni-Effect, Ouzo effect, etc.)				
Competencies acquired by the student	• Students will posses insight in important interfacial aspects including interfacial energy and surface potential and be able to relate this to interpreting interfacial phenomena or observations. • Students will be able to explain and mathematically describe different interfacial phenomena, such as: wetting, colloidal stability. • Students will be familiar with experimental techniques for measurement of various colloidal and interfacial properties (ex. zeta potential, streaming potential, contact angle, etc.) and interpretation/limitations of these measurements. • Students will understand the applicability and limitations of various colloid-related theoretical frameworks, such as DLVO/XDLVO. • Students will be able to critically evaluate scientific literature on interfacial phenomena				
System for assessment and evaluation	Weekly group assignment (60%), Exam (40%)				
Key words	Interfaces, surface phenomena				

Course name	**Multicomponent mass transport in water treatment**					
ECTS Credits	5	**Track/Semester**	Energy - S3	**Type**	Mandatory	
Course coordinator	Benes & Kemperman			**HEI**	University of Twente	
Activities	**Lectures :** 8h	**Tutorials:** 0h		**Practicals:** 0h		
Lecturer(s)	Benes & Kemperman					
Used sources	Membrane Technology and Applications, Richard Baker					
Short description of course contents	This course aims at understanding of mass transport in multi-component mixtures, based on a simplified version of the theory of Maxwell and Stefan. Main aim is for students to be able to understand the basic principles of diffusion in mixtures containing various different species, driven by a combination of different driving forces, and to apply this understanding in specific relevant chemical technology applications. Within the course a lot of attention is paid to contemplation and discussion, in order to consolidate the new knowledge and insights. Within this context, students are requested to give a lecture on one of the chapters in the book and to answer relevant case study, in which the multi-component characteristics of transport are evident. The case study involves the use, and stepwise extension, of an existing Matlab code, allowing the students to gradually and relatively independently simulate and study an eventually complex problem. The course relies on prior knowledge from: Equilibria II, Fysical Chemistry, iFTV, FTV, Separation Technologies. The following topics are addressed: - Limitations of the law of Fick; - Driving forces for diffusion (potential gradients); - Friction between molecules; - Maxwell-Stefan (MS) concept; - Bootstrap; - Application of MS in relevant process (membranes, heterogeneous catalysis, transport at interfaces); - Extending Matlab code for relatively complex simulation					
Competencies acquired by the student	• Describe a number of limitations of the law of Fick, and mention physical processes for which these have implications; • Explain the concept of driving forces for mass transport by diffusion, and list 4 examples of driving forces; • Explain the concept					
System for assessment and evaluation	Exam (50%), Report on assignment (50%)					
Key words	Diffusion, driving forces, molecule frictions					

Course name	**Membranes for gas separations**				
ECTS Credits	5	**Track/Semester**	Energy - S3	**Type**	Mandatory
Course coordinator		De Vos		**HEI**	University of Twente
Activities	**Lectures :** 8h	**Tutorials:** 0h		**Practicals:** 8h	
	De Vos				
Used sources	Membrane Technology and Applications, Richard Baker				
Short description of course contents	1. Introduction, basic principles and theory 2. Polymer membranes 3. Metallic membranes 4. Carbon, zeolite and micro-porous (sol-gel derived) ceramic membranes 5. Mixed conducting oxide membranes 6. Competitive technologies for gas separation and treatment (cryogenic distillation, pressure swingadsorption, absorption methods etc.) 7. Gas separation in a process 8. Weekly practical training				
Competencies acquired by the student	Membranes for Gas Separation is a course on membranes with a strong focus on membrane materials and molecular interactions. In most membrane based Gas Separations, the gas molecules will need to absorb in the membrane material, to be able to diffuse to th				
System for assessment and evaluation	Assignments (20%), Presentation (20%), Report on practical (60%)				
Key words	Membrane materials, molecular Interaction, adsorption/diffusion				

Course name	**Membrane process plant design**				
ECTS Credits	5	**Track/Semester**	Energy - S3	**Type**	Mandatory
Course coordinator		de Grooth		**HEI**	University of Twente
Activities	**Lectures :** 8h	**Tutorials:** 0h		**Practicals:** 0h	
Lecturer(s)	De Grooth				
Used sources	Handouts and other literature will be provided during the course				
Short description of course contents	Design and evaluation of an industrial scale (membrane) process plant based on a limited amount of information. The method taught for the analysis and design of chemical processes uses methods for 'conceptual design' and 'process systems design' which have been developed in the last twenty years. The lectures use fundamentals of this approach and translate them into applications in this case with special focus on membrane processes. Course content: • systematic process design • process simulation • process equipment design • process economics • technical and economical evaluation				
Competencies acquired by the student	Learning to systematically design and (technically & economically) evaluate a chemical process on an industrial scale in which membranes play a role.				
System for assessment and evaluation	Report and presentation on Process Design (100%)				
Key words	Process simulations, process economics, process equipment				

Course name	**Electrochemistry: Fundamentals & Technology**				
ECTS Credits	5	**Track/Semester**	Energy - S3	**Type**	Mandatory
Course coordinator	Mei			**HEI**	University of Twente
Activities	**Lectures :** 8h	**Tutorials:** 8h		**Practicals:** 0h	
Lecturer(s)	Mei				
Used sources	Thomas F. Fuller, John N. Harb, Electrochemical Engineering				
Short description of course contents	Content Electrochemistry deals with the conversion between electrical energy and chemical change. Electrochemical processes are highly used in various branches of the industry and have an ever-increasing impact in our everyday life. Think, for example, of consumer products like batteries (e.g. in note books, smart phones or cars), electrosynthesis, electroplating or production of hydrogen by electrolysis of water. With more solar and wind energy being produced, a sustainable electricity supply will rely on storage. Additionally, noting that fossil-based fuels will be phased out production of chemicals and fuels by alternative means will be required. Here, electrochemistry offers sustainable solutions but further improvement of current and emerging electrochemical conversion techniques is certainly needed. The course consists of five parts: - Lectures and tutorials deal with the fundamental principles of electrochemistry, including thermodynamics, double layer structure, electrode reactions, and mass transport in electrochemical systems. Main experimental techniques for the study of electrode reactions such as voltammetry and electrochemical impedance spectroscopy will also be discussed. - Online Workshops (3x): During the online workshops the student will be exposed to a series of simple electrochemical measurements. Experiments will be streamed online and performed by an experienced researcher. Before each (live) experiment students will be asked to fill-in a short questionnaire related to the respective experiment. Based on the visual observations students will be asked to re-evaluate their answers and discuss the results of measurements based on the fundamental principles elaborated on in the lectures and tutorials. - Topical lectures (2x) will expose students to relevant electrochemical research activities carried out by researchers within our faculty/in the Netherlands. - Project/Presentation: Students (in a group of max 2 students) will be asked to deliver a short presentation of max. 15 min (+5 min Q&A) on a topic of choice. The precise topic (list of suitable topics will be shared during the first lecture) will be defined in the first lecture of the course. Topics include but are not limited to: applications of state-of-the art electrochemical techniques and existing and emerging electrochemical processes. Presentations connect to the fundamentals and techniques lectures (point 1). Projects/Presentations and Q&A will be evaluated and account for 25% of the final grade. - The final written exam will account for 75% of the grade.				
Competencies acquired by the student	The objective of this course is to provide an introductory to electrochemistry. The course treats fundamental concepts as well as main experimental techniques and will be delivered using lectures and tutorials. The course should enable students to apply e				
System for assessment and evaluation	Exam (75%), Presentation (25%)				
Key words	Electrode and electrode processes, techniques, in-lab teaching				

Course name	**Capita Selecta**				
ECTS Credits	5	**Track/Semester**	Energy - S3	**Type**	Mandatory
Course coordinator		De Vos		**HEI**	University of Twente
Activities	**Lectures :** 0h	**Tutorials:** 0h	**Practicals:** 0h		
Lecturer(s)	All lectureres				
Used sources	Literature				
Short description of course contents	Capita Selecta is a specialized course offered by our research groUT3. The content of a CS course is determined on an individual basis and can be used as a preparation for the MSc assignment or to deepen knowledge in a particular topic. Depending on the background, need and interest of the student, an individual assignment (theoretical as well as practical) is discussed. The course is offered in form of self-study. Support is offered in personal consulting sessions with the student. Assessment depends on the chosen assignment The Course Membrane Technology CS allows the student to get acquitted with a certain specific aspect of membrane technology. The course is guided self-study and involves the writing of an extensive report on a membrane related topic to be chosen by the student in consultation with the supervisor. Next to a literature study, it can also include some experimental work, some calculations, a process design etc. as long as it is dedicated to a membrane technological topic. The work is concluded with a report.				
Competencies acquired by the student	The student will have learned to search for information and to read academic manuscripts on a topic of interest, and to subsequently evaluate and discuss the obtained information.				
System for assessment and evaluation	Report (100)%				
Key words	Literature Review, Student lead learning,				

Food, Bio and Health

Course name	**Membranes in Downstream Processing**				
ECTS Credits	6	**Track/Semester**	Food, Bio and Health - S3	**Type**	Mandatory
Course coordinator		João Crespo		**HEI**	Universidade Nova de Lisboa
Activities	**Lectures :** 28h	**Tutorials:** 12h		**Practicals:** 6h	
Lecturer(s)	João Crespo, Svetlozar Velizarov, Cláudia Galinha, Luísa Neves, Sylwin Pawlowski				
Used sources	Lecture notes				
Short description of course contents	This course will provide the fundamentals of membranes in downstream processing. Particular attention will be given to the design and application of membrane processes, within integrated separation schemes, due to their low energy consumption and high efficiency. 1. Introduction and general concepts; 2. Specificity of biological complex media and media /membrane interactions; 3. Pressure driven processes (micro- and ultra- filtration, nanofiltration, and reverse osmosis); 4. Activity driven processes (gas separation, vapour permeation and pervaporation); 5. Electromembrane processes; 6. Process monitoring and control; 7. Hybrid processes and process integration.				
Competencies acquired by the student	**Specific Competences** 1. To acquire general concepts about downstream processing 2. To be able to apply previous knowledge, acquired in separation processes and transport phenomena, in the processing of biological media 3. To be able to design process integration schemes 4. To acquire knowledge about emerging process monitoring tools and their use for process control 5. Understand how a specific problem may be approached by the Industry **Generic Competences** 6. Development of communication skills. 7. Development of problem-solving competences 8. Ability to perform autonomous work 9. Ability to perform data mining				
System for assessment and evaluation	1. Assistance and participation in class, lab sessions and in the seminars 2. Written reports of lab works 3. Individual seminar 4. Home assignments 5. Examination				
Key words	Membrane processes; process monitoring and control; process integration.				

Course name	**Membranes in Food Applications and Biorefinery**				
ECTS Credits	6	**Track/Semester**	Food, Bio and Health - S3	**Type**	Mandatory
Course coordinator		Isabel Coelhoso		**HEI**	Universidade Nova de Lisboa
Activities	**Lectures :** 28h	**Tutorials:** 12h		**Practicals:** 6h	
Lecturer(s)	Isabel Coelhoso, João Crespo, Carla Brazinha, Vanessa Pereira				
Used sources	Lecture notes				
Short description of course contents	This course will focus on the use of membrane processes in food processing, as well as, in biorefining. The design and use of membranes in food packaging with improved mechanical and barrier properties will also be addressed. The use of membranes in biorefinery processes will be discussed using a case study approach. Properties of barrier membranes. Packaging. Active and intelligent packaging. Nanocomposites - formulation, properties, and applications. Polymer rheology; Structural, mechanical, and thermal properties. Transport properties of barrier membranes. Sorption, diffusion, and permeability. Permeability in polymer blends, multilayers, and composites. Unsteady-state molecular diffusion and permeability. Membranes with reactive carriers. Barrier membranes with scavengers-blends or layers. Mathematical modelling. Selected case-studies of barrier membranes for food applications. New challenges. Biorefinery processes – principles and case studies: Valorization of microalgae (harvesting, media reuse and production of added-value compounds. Valorization of agrofood residues (solid, liquid and vapour streams).				
Competencies acquired by the student	**Specific Competencies** 1. To acquire general concepts about barrier membranes 2. To be able to model mass transport in complex barrier membrane systems 3. To acquire knowledge about emerging materials for barrier membranes 4. To acquire knowledge about emerging applications for barrier membranes 5. Understand specific challenges in biorefinning 6. Design of integrated processes in biorefinning 7. Understand how a specific problem may be approached by the food industry **Generic Competences** 8. Development of communication skills 9. Development of problem-solving competences 10. Ability to perform autonomous work 11. Ability to perform data mining				
System for assessment and evaluation	1. Assistance and participation in class, lab sessions and in the seminars 2. Written reports of lab works 3. Individual seminar 4. Home assignments 5. Examination				
Key words	Barrier membranes; biorefinery; valorization of agrofood residues.				

Course name	**Membranes in Biomedicine**				
ECTS Credits	6	**Track/Semester**	Food, Bio and Health - S3	**Type**	Mandatory
Course coordinator		Carla Portugal		**HEI**	Universidade Nova de Lisboa
Activities	**Lectures :** 28h	**Tutorials:** 12h		**Practicals:** 6h	
Lecturer(s)	Carla Portugal, Margarida Cardoso				
Used sources	Lecture notes				
Short description of course contents	This course will focus on the design and use of membranes with improved performance in biomedicine, namely in drug delivery, tissue culture and artificial organs. Principles of Tissue Engineering and ethical issues -Tissue scaffolds: main requisites and fabrication methods -Influence of scaffolds chemical, structural, mechanical, and mass transport characteristics on the development of cell tissues (protein-scaffold interactions, mechano-transduction) -Types of drug carriers: materials, methods for production, mechanisms of delivery involved and their impact on the drug biodistribution and optimization of the different administration routes -Drug delivery in organs and tissues - applications in cancer, inflammation, and regenerative medicine -Membrane processes for blood purification – hemodialyzers, bioartificial liver -Design of pancreatic systems -Blood oxygenators: configurations, essential requirements, and mass transport limitations in membrane contactors				
Competencies acquired by the student	**Specific Competencies** 1. To acquire knowledge about development and characterization of membranes for Tissue Culture and Artificial Organs 2. To be able to model transport in complex Tissue Culture and Artificial Organs systems 3. To acquire knowledge about emerging materials for Tissue Culture and Artificial Organs 4. To acquire knowledge about emerging applications in Tissue Culture and Artificial Organs **Generic Competences** 6. Development of communication skills 7. Development of problem-solving competences 8. Ability to perform autonomous work 9. Ability to perform data mining				
System for assessment and evaluation	1. Assistance and participation in class, lab sessions and in the seminars 2. Written reports of lab works 3. Individual seminar 4. Home assignments 5. Examination				
Key words	Membranes in medicine; tissue engineering; drug controlled release.				

Course name	**Business Project**				
ECTS Credits	6	**Track/Semester**	Food, Bio and Health - S3	**Type**	Mandatory
Course coordinator		Fernanda Lussá		**HEI**	Universidade Nova de Lisboa
Activities	**Lectures :** 28h	**Tutorials:** 28h		**Practicals:** 0h	
Lecturer(s)	Fernanda Llussá				
Used sources	Lecture notes				
Short description of course contents	This course intends to motivate students for entrepreneurship and the need for technological innovation. Each student will work with a selected membrane technology focusing on building a go-to-market strategy. The final output will be a business plan presented to invited guests. Contents Lecture 1. Introduction. "Entrepreneurship & Innovation from the Practitioner's Point of View". Setting up teams. Lecture 2. Value Creation Wheel and Market Analysis Lecture 3. Intellectual Property Lecture 4. How to create, capture and deliver value from a technology Lecture 5. Rehearsal of Midterm Presentation Lecture 6. Midterm Presentation Lecture 7. Marketing, Digital Marketing and Business Plan Lecture 8. Introduction to Accounting Lecture 9. Introduction to Financial Calculus Lecture 10. Free Cash Flow and Discounted Free Cash Flow Lecture 11. Rehearsal of Final Presentation Lecture 12. Final Elevator Pitch				
Competencies acquired by the student	At the end of this course the student will have acquired knowledge, skills and competencies that allow to: - Understanding the process of value creation associated with an entrepreneurial orientation, since the generation of innovative ideas to business decisions that lead to market implementation, including key information to prepare a business plan and do an "elevator pitch"; - Being able to, in autonomy, collect relevant information and formulate business ideas and analyze the necessary resources and implementation of the business, from production to quantification of the market and how to reach it, as well as calculate the profitability of the project; - Know the fundamentals, data sources and methods of analysis that build into a summary presentation of a business idea -business plan and "elevator pitch" - combining the generation of ideas, technology, market analysis and marketing, team and financial instruments to assess the profitability of the project.				
System for assessment and evaluation	1. Written report 2. Oral Presentation and defence				
Key words	Business project; value creation; entrepeneurship				

Course name	**Engineering Project**				
ECTS Credits	6	**Track/Semester**	Food, Bio and Health - S3	**Type**	Mandatory
Course coordinator		Joe da Costa		**HEI**	Universidade Nova de Lisboa
Activities	**Lectures :** 28h	**Tutorials:** 28h		**Practicals:** 0h	
Lecturer(s)	Joe da Costa				
Used sources	Lecture notes				
Short description of course contents	This course will address membrane technology, sustainability, and economic evaluation in a single applied engineering project. Each group of students (3- 4) will prepare a short project for the Industry, Consultants, Government Agencies or NGOs requirements. **Membrane Engineering** • Membrane technology • Process principles (PFD - process flow diagrams) • Mass and Energy balance • Project application • Size membrane area • Project optimisation (simple optimisation via PFD for example) **Sustainability** • Principles of sustainability • Environmental indicators • Principles of cleaner production • Sustainability and circular economy • Sustainability Assessment Framework **Business** • Economic Analysis (IRR, NPV, etc.) • Project costing • Business assessment • Business case				
Competencies acquired by the student	• Competence to conceptualise open real-world projects. • Apply principles of membrane engineering, sustainability, and business into a single project. • Project management skills, including report writing and short oral presentations. • Competence to prepare short projects to the Industry, Consultants, Government Agencies and NGOs.				
System for assessment and evaluation	• Mid-term report (30%) and oral presentation (10%) • Final report (50%) and oral presentation (10%) • Peer assessment for oral presentations only based on 1) slide information quality, 2) presentation flow, 3) technical content and 4) question time. • Report rubric marking based on "critical thinking standards" as seen in R.W. Paul & L. Elder (2002) – Critical Thinking, and R.W. Paul, R. Niewoehner & L. Elder (2007) – The thinker's Guide to Engineering Reasoning.				
Key words	Membrane technology, engineering, sustainability and economics.				

Water

Course name	**Integrated Water Resources Management: International Aspects VVRF01**				
ECTS Credits	7.5	**Track/Semester**	Water - S3	**Type**	Mandatory
Course coordinators		Linus Zhang, Erik Nilsson		**HEI**	Lund University
Activities	**Lectures :** 18h	**Tutorials:** 4h		**Practicals:** 4h	
Lecturer(s)	Linus Zhang and Kamshat Tussupova				
Used sources	Integrated Water Resources Management Plans (Training Manual and Operational Guide), By Cap-net.org, CIDA and GWP/UNDP; PDF available. I 2. Integrated Water Resources Management in Practice Better Water Management for Development, Roberto Lenton and Mike Muller(Ed): ISBN 9781844076505. (Selected Chapters in PDF). I 3. Institutional Arrangement for Integrated River Basin Management, by Yang X., L. Zhang and Qiu X., Changjiang Press, China. ISBN 978-7-5492-1349-8, pp336. Book available at the Department for purchase.				
Short description of course contents	The aim of the course is to prepare the students for international water related work in an international perspective. The course has the focus on Integrated Water Resources Management and is implemented with the help of practical examples and research projects.				
Competencies acquired by the student	Knowledge and understanding For a passing grade the student must gain deep knowledge and good insight on the meaning of Integrated Water Resources Management in a global sense. have good comprehension of technical and non-technical issues on Integrated Water Resources Management. be well familiar with most common environmental and water problems in both developed and developing countries. Competences and skills For a passing grade the student must be able to present a scientific project proposal, written in English, with emphasis on addressing water problems in international aspects. I be able to apply the learned knowledge by providing proposals for solving practical water problems and by argumenting for their opinions in important issues regarding to Integrated Water Resources Management. Judgement and approach For a passing grade the student must show ability of critical and comprehensive thinking in evaluating various current as well as future international water problems. *Theoretical Review:* Integrated Water Resources Management with regard to: floods, droughts, drinking water, sanitation and pollution. These issues will be studied with an emphasis on scientific and technical aspects, but also taking other aspects into account. Non-technical aspects: international organisations, water related international aid, politics and administration related to water as well as water economy. *Project Work:* Project work/case-studies are incorporated with international representative and interesting water problems.				
System for assessment and evaluation	Examination is based on one compulsory round-table debate session, one bigger project assignment (carried out in groUT3) and a written examination. Scoring of assignment is based on form, scientific content and the oral presentation of the written report. The written exam is of "closed book" type and consists of open questions treated within the course. The course grade is a weighted average of the two course components. The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.				
Key words	Water Resources Engineering.				

Course name	**Water and Wastewater Treatment VVAN25**				
ECTS Credits	7.5	**Track/Semester**	Water - S3	**Type**	Mandatory
Course coordinator		Åsa Davidsson		**HEI**	Lund University
Activities	**Lectures :** 30h	**Tutorials:** 44h		**Practicals:** 8h	
Lecturer(s)	Michael Cimbritz and Åsa Davidsson				
Used sources	Mackenzie L. Davies: Water and Wastewater Engineering, Design Principles and Practice. McGraw Hill, 2010, ISBN: 978-0-07-171384-9. Other material is added through the course web.				
Short description of course contents	Drinking water production plants and wastewater treatment plants are essential parts of the urban water infrastructure and have a large influence on the hydrological cycle. To protect the environment and the environmental services the ecosystems provide, water needs to be handled in an environmentally sustainable way. The aim of the course is to provide knowledge about water and wastewater treatment to be able to design and operate municipal facilities for production of drinking water and treatment of wastewater in the urban area.				
Competencies acquired by the student	*Knowledge and understanding* For a passing grade the student must account for different parameters and how they influence municipal drinking water production and wastewater treatment *Competences and skills* For a passing grade the student must based on given pre-requisites be able to choose and design processes for municipal drinking water production and wastewater treatment (including sludge treatment) show the ability to perform team work in group by a limited, in-depth project work on water treatment show the ability to adjust written and oral presentation of the results from a project work to an assigned target group Judgement and approach For a passing grade the student must by collecting and compiling information relevant for design calculations and operation of municipal drinking water production plants and municipal wastewater treatment plants demonstrate an ability to analyse and evaluate different kinds of information				
System for assessment and evaluation	Written examination. Project assignment including oral and written presentation and participation in laboratory assignment. The grade is based on the written examination. The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.				
Key words	Survey of water resources, water consumption and water quality Treatment processes for potable water Wastewaster systems Physical, chemical and biological treatment processes Sludge treatment Small-scale wastewater management				

Course name	**Project Course Part I VVAN10**				
ECTS Credits	7.5	**Track/Semester**	Water - S3	**Type**	Mandatory
Course coordinator		Karin Jonsson		**HEI**	Lund University
Activities	**Lectures :** 4h	**Tutorials:** 40h		**Practicals:** 8h	
Lecturer(s)	Frank Lipnizki				
Used sources	Relevant articles and literature within the chosen area.				
Short description of course contents	The student shall within the limits of the course delve into a limited problem within the subject of water and environmental engineering. Supervised self-tuition, field work and/or laboratory work. The content of the course is defined for each student/group of students in consultation between student/students and supervisor. The content shall be a limited problem within the subject of water and environmental engineering. The project shall be reported in a written report in Swedish or in English and orally in a discussion with the supervisor or at an officially announced seminar.				
Competencies acquired by the student	Knowledge and understanding For a passing grade the student must I be able to independently analyze and value problems within the subject of water and environmental engineering. I have acquired deepened knowledge within the chosen subject. Competences and skills For a passing grade the student must in consultation with a supervisor be able to plan and carry out a minor project within the area of water and environmental engineering. have a general ability to independently be able to find, treat and compile information relevant to the project. independently be able to create a simpler report in Swedish or in English. be able to, in Swedish or in English, orally report the chosen problem and account for chosen solutions in relation to the literature. *Judgement and approach* For a passing grade the student must be able to critically examine, value and draw conclusions from scientific literature.				
System for assessment and evaluation	Written report. The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.				
Key words	Water Resources Engineering.				

Course name	**Project Course Part II VVAN15**				
ECTS Credits	7.5	**Track/Semester**	Water - S3	**Type**	Mandatory
Course coordinator		Karin Jonsson		**HEI**	Lund University
Activities	**Lectures :** 4h	**Tutorials:** 40h		**Practicals:** 8h	
Lecturer(s)	Frank Lipnizki				
Used sources	Relevant articles and literature within the chosen area.				
Short description of course contents	Supervised self-tuition, field work and/or laboratory work. The content of the course is defined for each student/group of students in consultation between student/students and supervisor. The content shall be a limited problem within water and environmental engineering. The project shall be reported in a written report in Swedish or in English and orally in a discussion with the supervisor or at an officially announced seminar				
Competencies acquired by the student	*Knowledge and understanding* For a passing grade the student must be able to independently analyze and value problems within the subject of water and environmental engineering. Have acquired deepened knowledge within the chosen subject. *Competences and skills* For a passing grade the student must independently be able to plan and carry out a minor project within the area of water and environmental engineering. Have a deepened ability to independently be able to find, treat and compile information relevant to the project. Independently be able to create a simpler report in Swedish or in English. Be able to, in Swedish or in English, orally report the chosen problem and account for chosen solutions in relation to the literature. *Judgement and approach* For a passing grade the student must on a deepened level be able to critically examine, value and draw conclusions from scientific literature.				
System for assessment and evaluation	Written report. The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.				
Key words	Water Resources Engineering				