SYLLABUS

1. Information about the program

1.1 Higher education institution	Politehnica University Timisoara
1.2 Faculty[1]/ Department [2]	Chemical Engineering, Biotechnologies and Environmental Protection / CAICAM
1.3 Field of study (name/code[3])	Chemical Engineering / 10.30.50
1.4 Study cycle	License
1.5 Study program (name/code/qualification)	Chemical Engineering / 10.30.50.60 / engineer

2. Information about the discipline

2.1 Name of discipline/ formative category[4]			Green technologies for sustainable treatments of water and wastewater / DS				
2.2 Coordinator (holder) of course activities			Florica MANEA.				
2.3 Coordinator (holder) of applied activities[5]			Florica MANEA				
2.4 Year of study[6]	IV	**2.5** Semester	8	**2.6** Type of evaluation	E	**2.7** Regime of discipline[7]	DO

3. Total estimated time – hours / semester: direct teaching activities (fully assisted or partly assisted) and individual training activities (unassisted) [8]

3.1 Number of fully assisted hours / week	3.5 of which:	**3.2** course	2	**3.3** seminar / laboratory / project	0/1.5/0
3.1* Total number of fully assisted hours / semester	49 of which:	**3.2*** course	28	**3.3*** seminar / laboratory / project	0/21/0
3.4 Number of hours partially assisted / week	of which:	**3.5** training		**3.6** hours for diploma project elaboration	
3.4* Total number of hours partially assisted / semester	of which:	**3.5*** training		**3.6*** hours for diploma project elaboration	
3.7 Number of hours of unassisted activities / week	5.43 of which:	additional documentary hours in the library, on the specialized electronic platforms and on the field			
		hours of individual study after manual, course support, bibliography and notes			
		training seminars / laboratories, homework and papers, portfolios and essays			
3.7* Number of hours of unassisted activities / semester	76 of which:	additional documentary hours in the library, on the specialized electronic platforms and on the field			
		hours of individual study after manual, course support, bibliography and notes			
		training seminars / laboratories, homework and papers, portfolios and essays			
3.8 Total hours / week [9]	8.93				
3.8* Total hours /semester	125				
3.9 Number of credits	5				

4. **Prerequisites** (where applicable)

4.1 Curriculum	• Analytical Chemistry and Instrumental Analysis; Physical Chemistry; Transfer phenomena; Hydrodynamics; Principles of Chemical Engineering

[1] The name of the faculty which manages the educational curriculum to which the discipline belongs
[2] The name of the department entrusted with the discipline, and to which the course coordinator/holder belongs.
[3] The code provided in HG - on the approval of the Nomenclature of fields and specializations / study programs, annually updated.
[4] Discipline falls under the educational curriculum in one of the following formative disciplines: Basic Discipline (DF), Domain Discipline (DD), Specialist Discipline (DS) or Complementary Discipline (DC).
[5] Application activities refer to: seminar (S) / laboratory (L) / project (P) / practice/training (Pr).
[6] Year of studies in which the discipline is provided in the curriculum.
[7] Discipline may have one of the following regimes: imposed discipline (DI) or compulsory discipline (DOb)-for the other fundamental fields of studies offered by UPT, optional discipline (DO) or optional discipline (Df).
[8] The number of hours in the headings 3.1 *, 3.2 *, ..., 3.8 * is obtained by multiplying by 14 (weeks) the number of hours in headings 3.1, 3.2, ..., 3.8. The information in sections 3.1, 3.4 and 3.7 is the verification keys used by ARACIS as: (3.1) + (3.4) ≥ 28 hours / wk. and (3.8) ≤ 40 hours / wk.
[9] The total number of hours / week is obtained by summing up the number of hours in points 3.1, 3.4 and 3.7.

4.2 Competencies	• Description, analysis and use of fundamental concepts and theories in the field of chemistry, chemical engineering and the applications of tools for analysis and modern management of processes, including through digital systems •

5. Conditions (where applicable)

5.1 of the course	• Medium or large class room, equipped with video projector and internet connection; online
5.2 to conduct practical activities	• Lab room; online

6. Specific competencies acquired through this discipline

Specific competencies	• Assessment of drinking water and wastewater quality • Exploitation of drinking water and municipal/industrial wastewater treatment plants within the context of the circular economy and sustainable development • Identification of green solutions and their integration within existing or new treatment flow of wastewater including its recycling and reusing
Professional competencies ascribed to the specific competencies	• - Analyse production processes for improvement; • - Manage chemical testing procedures; • - Test materials; • - Write technical reports • -Performs chemical experiments • -Approve engineering design • -Assess environmental impact

Transversal competencies ascribed to the specific competencies

- - Conduct quality control;
- - Apply scientific, technological and engineering knowledge;
- - Uses equipment, instruments or technological equipment accurately.

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7. Objectives of the discipline (based on the grid of specific competencies acquired - pct.6)

7.1 The general objective of the discipline	• To assure the competencies and skills to understand circular management of water, environmental oriented issues related to anthropic activities especially chemical engineering, which generates the wastewaters, and technological aspects to prevent and mitigate their environmental impact, within the context of the sustainability and the circular economy
7.2 Specific objectives	• Evaluation of the impact of anthropic activities on water; • Legislation and quality characteristics of drinking water and municipal wastewater/residual effluents; • Identification/selection of the conventional/innovative unitary processes in the technological solution for the treatment of drinking water and wastewater/residual effluents; • Identification and integration of green solutions within drinking water and wastewater treatments • Integrating the concept of circular economy in the field of wastewater;

	• Evaluation of the proposed technology solutions

8. Content [10]

8.1 Course	Number of hours	Teaching methods [11]
I.1 Introduction in water circularity. Circular management of water sources. Drinking water and wastewater quality. Water use cycle.	2.	•powerpoint and/or blackboard, conversation and debate, exemplifying, problematization, case studies, video
I.2 Policies and law regulations in drinking water and wastewater.	2	
II. Green chemistry and technology in water treatment. Characteristics. Classification	2	
III.1 Conventional drinking water treatment technologies	2	
III.2 Conventional municipal wastewater treatment technologies	2	
IV. Biological processes in drinking water treatment vs Biological processes in municipal wastewater treatment. Case studies	4	
V.Nature-based solutions suitable for drinking water vs wastewater treatment. Case studies	4	
VI. Membrane-based technologies for drinking water vs wastewater treatment	4	
VII.Advanced oxidation processes in drinking water vs wastewater treatment (photocatalysis, electrooxidation, photoelectrocatalysis)	4	
VIII.CO2 sequestration in drinking water and wastewater treatment	2	

Bibliography [12]

1. ***Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment;
2. ***Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse;
3.*** The European Green Deal - European Commission (europa.eu);
4.***Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption;
5. Naushad, M., Rajendran, S., Lichtfouse, E., Green methods for wastewater treatments, Springer 2020, https://doi.org/10.1007/978-3-030-16427-0
6. Manea F., Pop A., Decontamination of Wastewater Containing Organics by Electrochemical Methods in: Water Treatment (Eds: W. Elshorbagy), Intech 2013;
7. Vasilie S., Manea F., Baciu A., Pop A., Dual Use of Boron-doped Diamond Electrode in Antibiotics-Containing Water Treatment and Process Control, Process Safety and Environmental Protection 117, 2018, p. 446
8. Baciu, A., Negrea, S., Manea, F., Electrocatalytic Degradation of Organic Pollutants from Water, in Photocatalysts and Electrocatalysts in Water Remediation: From Fundamentals to Full Scale Applications (Eds. P.Bhunia, K. Dutta, S. Vadivel), Ed.
9.Cross, K., Tondera, K., Rizzo, A., Andrews, L., Pucher, B.,Istenič, D., Karres, N., McDonald, R., Nature-Based Solutions for Wastewater Treatment: A Series of Factsheets and Case Studies, IWA Publishing, 2021
10. Baciu, A., Orha, C., Nicolae, R., Nicolaescu, M., Ilies, S., Manea, F. Advanced Electrochemical Degradation of Organic Pollutants from Water Using Sb-Doped SnO2/Ti Anode and Assisted by Granular Activated Carbon. Coatings 2023, 13, p.1127. https://doi.org/10.3390/coatings13061127
11. Vasilie, S., Vitan, L.-D., Tudoran, C.-A., Manea, F. Flexible Electroflotocoagulation Reactor: New Design and Testing in Treatment of Real Surface Water. Water 2022, 14, p.2990. https://doi.org/10.3390/w14192990
12. Blackburn, E. A. J.,. Dickson-Anderson, S. E., Anderson, W. B., Emelko, M. B. Biological Filtration is Resilient to Wildfire Ash-Associated Organic Carbon Threats to Drinking Water Treatment ACS ES&T Water 2023 3 (3), p.639 DOI: 1021/acsestwater.2c00209
13. Chin Hong Neoh, C.H., Noor, Z.Z., Noor, S., Mutamim, A., Chi K. L., Green Technology in Wastewater treatment technologies: Integration of membrane bioreactor with various wastewater treatment systems, Chemical Engineering Journal, 283, 2016, 582, https://doi.org/10.1016/j.cej.2015.07.060.
14. Apopei, P., Orha, C., Popescu, M.I., Lazau, C., Manea, F., Catrinescu, C., Teodosiu, C., Diclofenac removal from water by photocatalysis- assisted filtration using activated carbon modified with N-doped TiO2, Process Safety and Environmental

[10] It details all the didactic activities foreseen in the curriculum (lectures and seminar themes, the list of laboratory works, the content of the stages of project preparation, the theme of each practice stage). The titles of the laboratory work carried out on the stands shall be accompanied by the notation "(*)".

[11] Presentation of the teaching methods will include the use of new technologies (e-mail, personalized web page, electronic resources etc.).

[12] At least one title must belong to the discipline team and at least one title should refer to a reference work for discipline, national and international circulation, existing in the UPT library.

Protection,138, 2020, p. 324, https://doi.org/10.1016/j.psep.2020.03.012.

8.2 Applied activities [13]	Number of hours	Teaching methods
1.Assessment of drinking water and wastewater quality.	4	Experimental studies/problematization/discussion; conclusions for each experimental study
2. Natural filtering systems for drinking water	4	
3.CO2 sequestration for water softening	4	
4.Biological filtering system for ammonium removal through nitrification processes	4	
5. Application of re-used industrial waste based electrocoagulation for phosphorous recovery	4	
6. Results interpretation. Report	1	

Bibliography [14]

1. ***Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment;
2. ***Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse;
3.*** The European Green Deal - European Commission (europa.eu);
4.***Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption;
5. Baciu, A., Negrea, S., Manea, F., Electrocatalytic Degradation of Organic Pollutants from Water, in Photocatalysts and Electrocatalysts in Water Remediation: From Fundamentals to Full Scale Applications (Eds. P.Bhunia, K. Dutta, S. Vadivel), Ed. John Wiley & Sons Ltd, 2023
6. Baciu, A., Orha, C., Nicolae, R., Nicolaescu, M., Ilies, S., Manea, F. Advanced Electrochemical Degradation of Organic Pollutants from Water Using Sb-Doped SnO2/Ti Anode and Assisted by Granular Activated Carbon. Coatings 2023, 13, p.1127. https://doi.org/10.3390/coatings13061127
7. Vasilie, S., Vitan, L.-D., Tudoran, C.-A., Manea, F. Flexible Electroflotocoagulation Reactor: New Design and Testing in Treatment of Real Surface Water. Water 2022, 14, p.2990. https://doi.org/10.3390/w14192990
8. Blackburn, E. A. J.,. Dickson-Anderson, S. E., Anderson, W. B., Emelko, M. B. Biological Filtration is Resilient to Wildfire Ash-Associated Organic Carbon Threats to Drinking Water Treatment ACS ES&T Water 2023 3 (3), p.639 DOI: 10.1021/acsestwater.2c00209
9. Apopei, P., Orha, C., Popescu, M.I., Lazau, C., Manea, F., Catrinescu, C., Teodosiu, C., Diclofenac removal from water by photocatalysis- assisted filtration using activated carbon modified with N-doped TiO2, Process Safety and Environmental Protection,138, 2020, p. 324, https://doi.org/10.1016/j.psep.2020.03.012.

9. Corroboration of the content of the discipline with the expectations of the main representatives of the epistemic community, professional associations and employers in the field afferent to the program

- The teaching staff serving the discipline is involved in numerous fundamental and applied research projects at national and international level, which involves the inclusion in consortia with industry and local authorities/regional water-sewage operators (SC.Beespeed Automatizari SRL; SC Datcomp SRL; SC Datronic SRL., SC Linde Gas-Water and wastewater treatment; Regional Environmental Protection Agency, SC Aquatim SA. Both the course and the laboratory were developed in such a way as to meet the current requirements regarding the existence of installations intended for testing unitary processes or their combination including nature-based and green solutions for the development of various technological solutions (blue-green) for drinking water, wastewater and rainwater treatment

10. Evaluation

Type of activity	**10.1** Evaluation criteria [15]	**10.2** Evaluation methods	**10.3** Share of the final grade
10.4 Course	Acquiring general informations regarding the concept of circular economy in wastewater treatment technology; understanding the sustainability indicators	Examination by written and oral tests	66%

[13] Types of application activities are those specified in footnote 5. If the discipline contains several types of applicative activities then they are sequentially in the lines of the table below. The type of activity will be in a distinct line as: "Seminar:", "Laboratory:", "Project:" and / or "Practice/training".
[14] At least one title must belong to the discipline team.
[15] Syllabus must contain the procedure for assessing the discipline, specifying the criteria, methods and forms of assessment, as well as specifying the weightings assigned to them in the final grade. The evaluation criteria shall be formulated separately for each activity foreseen in the curriculum (course, seminar, laboratory, project). They will also refer to the forms of verification (homework, papers, etc.)

	for drinking water and wastewater treatment; mastering the main representative aspects regarding the quality of drinking water and wastewater (quality parameters/indicators); mastering the aspects related to the principles of different unitary processes including green solutions suitable for drinking water and wastewater treatment technology		
10.5 Applied activities	**S:**		
	L: The correct evaluation of the performance of a unitary process/technological solution for the treatment of wastewater considering also the process control parameters; the legislation and regulations regarding quality conditions	Oral evaluation by survey, at the beginning, during and at the end of each laboratory experiment.	34%
	P[16]**:**		
	Pr:		
10.6 Minimum performance standard (minimum amount of knowledge necessary to pass the discipline and the way in which this knowledge is verified [17])			
• The ability to identify the necessary elements to correctly select a technological solution for drinking water and wastewater treatments related to their quality-written test			

Date of completion	**Course coordinator (signature)** Prof.dr.ing. Florica MANEA	**Coordinator of applied activities (signature)** Prof.dr.ing. Florica MANEA
Head of Department (signature) Conf.dr.ing. Andrea KELLENBERGER	**Date of approval in the Faculty Council** [18]	**Dean (signature)** Ș.L.dr.ing. Mircea Laurențiu DAN

[16] In the case where the project is not a distinct discipline, this section also specifies how the outcome of the project evaluation makes the admission of the student conditional on the final assessment within the discipline.
[17] It will not explain how the promotion mark is awarded.
[18] The endorsement is preceded by the discussion of the board's view of the study program on the discipline record.