UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2022/2023
MASTER'S DEGREE (MSC)	ENGINEERING AND INNOVATIVE TECHNOLOGIES FOR THE ENVIRONMENT
INTEGRATED COURSE	ADVANCED PROCESSES AND ENVIRONMENTAL MODELS - INTEGRATED COURSE
CODE	20706
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	ICAR/03
HEAD PROFESSOR(S)	MANNINA GIORGIO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	MANNINA GIORGIO Professore Ordinario Univ. di PALERMO
CREDITS	9
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**MANNINA GIORGIO** Tuesday 09:00 11:00 Dipartimento di Ingegneria - Area Idraulica e Ambientale piano 2° ed. 8 Wednesday 9:00 11:00 Dipartimento di Ingegneria - Area Idraulica e Ambientale piano 2° ed. 8 - Ufficio no. SO8P2130

DOCENTE: Prof. GIORGIO MANNINA

PREREQUISITES	Any formal pre-requisites established.
LEARNING OUTCOMES	Knowledge and understanding The student at the end of a diligent and active frequency of the course will have conceptual, quantitative and modeling knowledge of the situations in which the waters and the waste require defined "advanced" treatments. He will have knowledge of the principles and technical use of physical, chemical and biological phenomena applied in treatments. - Ability to apply knowledge and understanding The student will be able to identify useful advanced processes in a given situation; place them appropriately in a chain of treatments; design at the "maximum" level the chemical, physical or biological reactors that carry out the desired treatment, using if necessary the results of scientific research not yet summarized in the technical manuals. - Autonomy of judgment The student will be able to understand the main commercial machines and equipment for advanced processes in the design principles and criteria; will be able to choose those that meet the needs of the case, and to propose additions to existing systems. - Communication skills The student will acquire the ability to carry out a design calculation or verification of advanced reactors in typical situations, and to introduce and comment on the calculations and results. He will be able to make sketches of the main artifacts of these plants. - Learning skills The student will be able to update the skills acquired with Technical Texts and Magazines and Catalogs of components for plants. You will be able to use the results of experiments made in pilot plants for design purposes.
ASSESSMENT METHODS	Final oral exam on the topics of the course; as a rule it consists of a preliminary examination of the exercises performed during the course, a theoretical demonstration, of an example of calculation. The grades go from 18 to 30 and praise + "rejected", falling back into practice in the 6 bands ECTS E, D, C, B, A, A +. Each exam is evaluated for itself, independently of the others sustained in the same Session.
TEACHING METHODS	Lectures + Exercises + Individual study

MODULE
ENVIROMENTAL MODELS

Prof. GIORGIO MANNINA

SUGGESTED BIBLIOGRAPHY

Dispense e materiale bibliografico sono distribuiti durante il corso. Per maggiori approfondimenti, si suggerisce la consultazione dei seguenti testi:

o Mannina G, Ekama G, Odegard H. Olsson G. “Advances in wastewater treatment”, ed. IWA-Publishing, 2019
o Chapman S.J. “Fortran 90/95 – guida alla programmazione”, ed. McGraw-Hill, 2000
o Chapra “Surface Water-Quality Modeling”, ed. McGraw-Hill, 1996
o Dochain D. & Vanrolleghem P.A. “Dynamical Modelling and Estimation in Wastewater Treatment Processes.” Ed. IWA Publishing, London, UK.
o Henze, M. Gujer, W. Mino, T. van Loosdrecht M., “Activated Sludge Models ASM1, ASM2d and ASM3.” IAWPRC Task Group on Mathematical Modelling for Design and Operation of Biological Wastewater Treatment, IAWPRC Scientific and Technical Reports No. 9, IWA Publishing, London, 2000.
o Masotti, L. "Depurazione delle acque", ed. Calderini, Bologna, 1987
o Metcalf & Eddy: "Wastewater engineering: treatment, disposal, reuse", ed. McGraw-Hill, N.Y., 1991
o Degremont: "Memento Technique de l'Eau" - ed. Degremont, Paris, 1989
o Montgomery, J.M. "Water treatment, principles and design", ed. J.Wiley and sons, N.Y., 1985
o Tchobanoglous G., Theisen H., Vigil, S.A. "Integrated solid waste management", ed. McGraw-Hill, 1993
o d'Antonio G. "Trattamento dei rifiuti solidi urbani", ed. Maggioli, 1997. o Restani W., Mari R. “Tutela dell’ambiente atmosferico”, ed. Pirola, 1995.

AMBIT	50372-Ingegneria per l'ambiente e territorio
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54

EDUCATIONAL OBJECTIVES OF THE MODULE

The topics covered in the module are intended to complete the preparation of the student engineers who intend to carry out their professional activity in the fields of environmental engineering, land planning and management, chemical and mechanical plant engineering. The course provides lessons and exercises, the latter mainly dedicated to the development of simple Fortran and Matlab language models and dedicated software (i.e., GPS-X).
Furthermore, the course aims to provide knowledge to be able to choose simulation models applied to environmental systems with particular devotion to quali-quantitative processes; acquire knowledge about the use of software, and develop consolidating knowledge for the use of environmental modeling techniques also through practical exercises.

SYLLABUS

Hrs	Frontal teaching
2	Course presentation
5	Foundamentals on environmental modeling: definitions, main quantities involved; objectives of mathematical modeling (research, design, control and diagnosis); examples and boundaries of a mathematical model; classification of mathematical models (fuzzy, stochastic, neural and deterministic); main steps for the construction and use of a mathematical model.
5	Review of the main methods of solving ordinary differential equations and related implementations: explicit and implicit Euler methods; the Runge-Kutta methods; convergence conditions. Fundamental balance equations: dynamic equations of mass conservation; dynamic equations of energy balance; auxiliary equations (chemical kinetics, hydrodynamics, etc ...); the concept of "closure" of the model; mass balances in dynamic conditions in a purification plant.
5	Sensitivity analysis, calibration and evaluation of the uncertainty of the inputs of a mathematical model: fundamentals and methodologies. Methods of local and global sensitivity analysis. Classification of the nature of the uncertainty of a model. Random sampling techniques: Latin Hypercube; the Monte Carlo method.
7	The Activated Sludge Models (ASMs) models: classification; format and notation; mass balance sheet; verification of continuity; switch functions; chemical and biological structure of ASMs models; kinetics of biological reactions; characteristics of the substrates present in the waste water. Definition of the processes and components of the ASM1, ASM2, ASM2d and ASM3 models. Applications of ASMs models.
4	Modeling of treatment systems for advanced waters: membrane (MBR), Moving Bed Biofilm Reactor (MBBR), integrated fixed film activated sludge (IFAS), hybrid systems
4	Outline of river quality models: the QUAL2K model; conceptual models - mechanistic. Notes on integrated models of urban water quality according to the D.lgs. 152/06. Outline of groundwater propagation models: the MODFLOW model.
4	Instrumentation, Control and Automation (ICA): fundamentals

Hrs	Practice

4	FORTRAN programming fundamentals: program structure; definition of special characters; initialization of a variable; type of expressions (integer, real, character and logical); use of operators; syntax of the main conditional logical statements (if- then-else, if "logical"; houses); combinatorial operators (and, or); cycle instructions (the DO cycle, the WHILE cycle); subroutine and function; declaration and use of carriers; examples; formatting; opening, closing and writing a file; calculation examples using FORTRAN.
4	Development of simplified models for water treatment through mass balances
6	Development of simplified models for water treatment through ASM-based approaches
2	Simulation of wastewater treatment plant schemes by means of software: conventional and advanced systems

MODULE
ADVANCED PROCESSES

Prof. GIORGIO MANNINA

SUGGESTED BIBLIOGRAPHY	
- Slide, Dispense e altro materiale didattico messo a disposizione dal docente.	
AMBIT	20937-Attività formative affini o integrative
INDIVIDUAL STUDY (Hrs)	48
COURSE ACTIVITY (Hrs)	27
EDUCATIONAL OBJECTIVES OF THE MODULE	
The adequate knowledge of the methodological-operational aspects related to the topics covered by the course and the ability to use this knowledge to interpret and describe the problems of engineering of water and waste advanced treatment processes .	

SYLLABUS

Hrs	Frontal teaching
16	Advanced treatments of civil and industrial wastewater: - MABR technology; - anaerobic and aerobic granular biomass technologies; - advanced oxidation processes.
10	AAdvanced treatment of sewage sludge: - chemical stabilization; - sludge drying treatments: with hihg temperature and using solar energy; sludge incineration.

Hrs	Practice
2	Equalization in waste water treatment plants.