Università degli Studi della Basilicata
Scuola di Ingegneria

COURSE: WATER QUALITY MODELLING			
ACADEMIC YEAR: 2018/2019			
TYPE OF EDUCATIONAL ACTIVITY: Characterizing			
TEACHER: DONATELLA CANIANI			
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phone: 0971/205209		mobile (optional): 320/4238704	
Language: Italian			
ECTS: 4 for theoretical lessons, and 2 for classroom tutorials	n. of hours: 36 hours for theoretical lessons, and 18 hours for classroom tutorials	Campus: Potenza School of Engineering Program: Master Degree in Environmental Engineering	Semester: I

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

It is a course of the ICAR / 03 Scientific Disciplinary Sector (Sanitary and Environmental Engineering) and examines the basic elements of modeling self-purifying processes that take place in natural water bodies.

Learning outcomes

The main objective of the course is to provide students with the basics to address the main phenomena of water pollution and the development and application of water quality models. At the end of the course, the student will be able to analyze the results of simulations conducted and to optimize the simulation parameters. The student will also be able to analyze and evaluate the characteristics of natural water quality with analytical and simulation methods.

At the end of the course, the student will acquire the following practical knowledge and methodologies:

- basic issues related to kinetics of chemical and biochemical reactions;
- basic knowledge dealing with mass balance and analysis of ideal and real reactors;
- the basics for the knowledge of the characterization parameters and for understanding the phenomena of natural water pollution;
- theoretical foundations of the main chemical, physical and biochemical processes of water self-purification;
- key features of the main simulation models available in the technical-scientific literature.

Learning results

The main skills (i.e. the ability to apply obtained knowledge) will be:

- to analyze and describe water pollution phenomena and basic elements of reaction kinetics;;
- to analyze the ideal reactors behavior by means of the mass balance equations;
- to identify the biological, chemical, and physical processes at the basis of self-purification processes of water bodies;
- to evaluate and describe the main simulation models available in the technical-scientific literature;
- to develop and implement water quality simulation models in natural water bodies.

Knowledge and understanding skills

At the end of the course, the student will have acquired knowledge and methodologies to address and solve problems related to the analysis of the main water pollution phenomena and the development and application of water quality models.

Autonomy of judgment

The student will have gained an integrated view of problems related to the pollution of natural water bodies, with particular attention to parameters and indicators of water quality and self-purification phenomena.

Communicative Skills

The student will be able to communicate with competence and language skills on the techniques of modeling and analysis of self-purification processes and the phenomena of pollution of natural water bodies.

Learning Skills

The student will be able to develop water quality models using mass balance equations and to apply models of water quality by using commercial and free software.

PRE-REQUIREMENTS

You must acquire and assimilate the following knowledge:

• basic concepts of "Sanitary and Environmental Engineering"

• Basic knowledge of differential equation resolution

CONTENTS OF THE COURSE

Fundamental criteria for the construction and use of simulation models: purpose of the models; components involved; static and dynamic balances; classification of surface water quality models; introduction to uncertainty analysis, Monte Carlo methods and sensitivity analysis; calibration; structure of river water quality models; extended transport equations; hydrodynamic model; transport equation, sub-model of conversion.

Characterization parameters and pollution phenomena of natural water: definitions and processes of self purification. Biochemical principles for the removal of pollutants from aquatic systems. Carbon cycle. Nitrogen cycle. Kinetics of reactions: reversible and irreversible reactions, homogeneous and heterogeneous reactions; order of reactions.

Ideal and real reactors: model of the batch reactor, model of the continuous flow stirred tank reactor (CFSTR); model of the plug flow reactor (PFR); general mass balance equation; analysis of the response of reactors to impulse signals and step signals; comparison between CFSTR and PFR reactors. Completely mixed systems: mass balances, steady-state and unsteady-state solutions and response times, feedforward and feedback systems of reactors. Not completely mixed systems: fundamental laws and methods of resolution. Computational tools for solving systems of differential equations: methods of Euler, Heun and Runge-Kutta.

Analysis and implementation of the main literature models. Characterization of river systems. Application to some environmental phenomena: eutrophication, thermal stratification, growth and bacterial decay, degradation of carbonaceous substrate, nitrogen and phosphorus. Calibration of the parameters of environmental systems. Parametric sensitivity analysis.

Construction of river water quality models, which are related to case studies, in Simulink (Matlab).

Analysis and application of widespread software (QUAL2K), also with reference to real cases.

TEACHING METHODS

The course provides 54 hours for theoretical lessons and exercises. Particularly, 36 hours will be theoretical lessons and 18 hours will be classroom tutorials. Seminars by external experts are provided, focusing on the biological nitrogen removal processes and GreenHouse Gas emissions from surface water bodies and wastewater.

EVALUATION METHODS

Oral examination. The exam focuses on the arguments investigated during the theoretical and tutorial lessons. To pass the oral exam the student must acquire at least 18 points out of 30.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

Teacher's handbook available on an online sharing platform with links provided by the teacher on the first day of the lesson or following an email request.

Textbook:

- Steven C. Chapra, Surface Water-Quality Modeling, McGraw-Hill, 1996.

INTERACTION WITH STUDENTS

- Firstly, the course aims, syllabus, and evaluation methods will be defined. Secondly, the professor's handbook will be provided by means of dropbox folders. Simultaneously, a student list will be done, including first name, last name, student ID, e-mail.
- Professor's office hours: Wednesday from 10.30 a.m. to 12.30 p.m. If there is the need to more explanations about the items argued during the course, further office hours could be defined subsequently, by contacting the professors by email or by phone.

EXAMINATION SESSIONS (FORECAST)[1] 13/09/2018, 11/10/2018, 15/11/2018, 13/12/2018, 17/01/2019, 14/02/2019, 14/03/2019, 11/04/2019, 16/05/2019, 13/06/2019, 18/07/2019
SEMINARS BY EXTERNAL EXPERTS YES X NO □
FURTHER INFORMATION

[1] Subject to possible changes: check the web site of the Teacher or the Department/School for updates.