Course: Analysis and Modeling of Environmental Processes		
Language: English		
Lecturer: Prof. Bruno Zelić, PhD		
TEACHING	**WEEKLY**	**SEMESTER**
Lectures	**3**	**45**
Laboratory	**0**	**0**
Seminar	**3**	**45**
		Overall: 90
		ECTS: 7

PURPOSE:

Application of process models for estimation of parameters and immeasurable states of the process, process optimization, up-scaling of lab-scale model simulation results on the pilot-plant and industrial scale, process control and product quality control.

THE CONTENTS OF THE COURSE:

1st week

Basic concepts about process. Basic definitions for the model. Classification of models: analytical and non-analytical, deterministic and stochastic, distributed and homogeneous, linear and non-linear, static and dynamic.

2nd week

Applications and examples of models. Engineering analysis of physical, chemical, biological and environmental processes – development of process models: scheme of process streams, mass and energy balance, model parameters, numerical methods for model solving, selection of computer programs and simulation software, simulations, model application.

3rd week

Linearization of models. Non-linear models and their steady-states, numerical methods for assessment of steady-states of non-linear systems. Jacobi iterative method, Newton-Raphson method, method of secants.

4th week

Models and simulations of 1st and 2nd order dynamical systems. Analytical solutions.

5th week

Laplace transforms and transfer functions.

6th week

Mathematical methods for solving od differential equations: Euler method, Runge-Kutta method, Rosenbrock method.

7th week

Discretization methods: finite difference method, method of lines, collocation method.

8th week

Estimation of model parameters, linear and non-linear regression analysis: trial and error method, least square method, simplex method, Nelder-Mead method.

1st partial test

9th week

Model sensitivity analysis, stability of solutions. Model simulations.

10th week

Application of model simulation results for optimization, design and control of processes.

11th week

Experimental plan and process optimization: Evolutionary operation (EVOP), genetic algorithm, simplex method, Rosenbrock method.

12th week

Case study 1. Production of pyruvic acid.

13th week

Case study 2. Industrial aerobic waste-water treatment.

14th week

Case study 4. Treatment of air pollution caused by galvanizing industry.

15th week

Case study 4. Transport of pollutant in porous media.

2nd partial test

GENERAL AND SPECIFIC COMPETENCE:

Achieving of basic knowledge needed for solving of case studies - process analysis and modeling using chemical engineering methodology.

KNOWLEDGE TESTING AND EVALUATION:

Continuous grading and evaluation during teaching – 100 points

a) Partial tests (2) – 50 points

b) Project – 35 points

b) Home work (4) – 10 points

c) Class attendance – 5 points

or

Written exam – 100 points

MONITORING OF THE COURSE QUALITY AND SUCCESSFULNESS:

University of Zagreb student survey

LITERATURE:

1. E. Holzbecher: Environmental Modeling using Matlab®, Springer-Verlag, Berlin, 2007.
2. J. Mikleš, M. Fiklar: Process Modeling, Identification and Control, Springer-Verlag, Berlin, 2007.
3. Plazl, M. Lakner: Uvod v modeliranje procesov, Univerza v Ljubljani, Ljubljana, 2004.
4. J.B. Snape, I.J. Dunn, J. Ingham, J.E. Prenosil: Dynamics of Environmental Bioprocesses, VCH, Weinheim, 1995.
5. K.T. Valsaraj: Elements of Environmental Engineering, Thermodynamics and Kinetics, Lewis Publishers, Boca Raton, 2000.
6. W.W. Nazaroff: Environmental Engineering Science, John Wiley & Sons, New York, 2001.