MODULE INFORMATION SHEET

Name of Module Unit	**Modeling and Simulation of Gas Networks**
Name in polish language	Modelowanie i symulacja sieci gazowniczych
Module type	~~compulsory~~ / elective
Form of studying	full-time day courses
Level of study	undergraduate course (B.Sc. level)
Type of study (for extra-mural courses)	-
Programme	Environmental Engineering
Speciality	Environmental Engineering
Responsible department	Department of Power Engineering and Gas Heating Systems - Gas Engineering Group
Responsible person	Ferdinand Uilhoorn D.Sc, PhD

Semester	Lectures(E)	Tutorials	Laboratory	Computer Exercises	Projects	ECTS
7	15			30		3

Objectives (summary)

The subject gives students an introduction in modeling and simulation of gas pipeline networks. The concept of data assimilating in flow modeling is introduced. The course features the use of in-house software. After completing the course, the student should be able to:

i. Understand the theoretical framework of modeling gas networks and its elements (pipes, compressor stations, pressure regulator stations and valves)
ii. Familiar with numerical methods for solving the gas flow equations
iii. Understand the behavior of gas networks under certain operating conditions, identify bottlenecks, evaluate capacity, plan network expansion and analyze security of supply.
iv. Introduction in the concept of data assimilating applied to flow modeling.

Prerequisites

1. Knowledge of mathematical analysis, fluid mechanics and thermodynamics.
2. Ability to interpret and present results.

Rules for integrated grade definition

Exam 60% and project 40%.

Recommended readings

T. Koch, B. Hiller, M. Pfetsch and L. Schewe. Evaluating Gas Network Capacities, SIAM, 2015.
J. Kralik, P. Stiegler, Z. Vostry and J. Zavorka. Dynamic modeling of large-scale networks with application to gas distribution. United States: N. p., 1988.
C. B. Laney. Computational Gasdynamics. Cambridge University Press, 1998.
A. J. Osiadacz. Simulation and analysis of gas network. E&FN Spon., London. 1987.
B. Ristic, S. Arulampalm and N. Gordon. Beyond the Kalman filter: particle filters for tracking applications, Boston, Ma.; London: Artech House, 2004.

Contents of lectures (syllabus)

	Topics	Time (hrs.)	Scope (S / Ex)
1	Introduction in gas transmission	1	S
2	Physical and technical fundamentals of gas networks i) gas properties – equation of state, ii) elements – pipes (gas flow dynamics, steady/unsteady state, isothermal/nonisothermal), resistors, valves, compressors stations (turbo/piston compressor – characteristic diagrams), iii) structure and representation (Kirchhoff's laws, Newton nodal, loop and loop-node method)	4	S
3	Numerical solution methods (explicit, implicit, finite-difference, finite volume, time stepping schemes)	4	S
4	Validation, verification and uncertainty quantification	2	S
5	Data assimilation in flow modeling (Kalman filters, ensemble methods)	4	S+R
	Total	**15**	**hours**

S – topics listed in the legal study programme standards from 12.07.2007
Ex – extended topics

Lecturers

Ferdinand Uilhoorn D.Sc. PhD, Maciej Chaczykowski D.Sc., PhD

Assessment method

Written examination

Contents of computer exercises

	Topics	Time (hrs.)	Scope (S / Ex)
1	Simulations exercises are done to examine the behaviour of gas networks under certain operating conditions, identify bottlenecks, evaluate capacity, plan network expansion and analyze security of supply.	30	S
	Total	**30**	**hours**

S – topics listed in the legal study programme standards from 12.07.2007
Ex – extended topics

Persons responsible for computer exercises

Łukasz Kotyński PhD

Assessment method for computer exercises

Conducting a project. Report with problem formulation, assumptions, method of solution, results and conclusions)