General information about courses:

1. Air Pollution Protection (4 ECTS)

The objective of the course is to introduce a student with the basic terms of air pollution protection as well as to adopt the knowledge and skills necessary in the procedures of waste gasses purification.

Within lectures, the following will be delivered:

- Introduction and basic terms in the field of air pollution protection
- Main sources of air pollution: metallurgy, mineral sources industry, process chemical industry, wood etc.
- Air pollution problem solution
- Procedures for minimisation of solid particles and gaseous compounds emissions
- Procedures for minimisation of greenhouse emission: process optimisation, energy saving, use of renewable energy sources
- Procedures for emission minimisation: process optimisation, raw materials exchange, incorporation of exhaust gasses purification devices
- Basic elements and ventilation systems design
- Basic types of exhaust gasses purification devices
- Selection of devices for waste gasses purification
- Devices operating on the basis of gravitational, inertial and centrifugal forces: cyclones, wet collectors, electrostatic precipitators, filters
- Planning and design of the waste gasses purification systems
- Elements of conceptual design
- Feasibility study Control of the waste gasses
- Measures integrated in the procedure of air pollution protection.

Seminars will include analysis of particular case studies from the field of environmental engineering.

Laboratory practicum will include introduction to the Gas Analyser 5000 and determination of parameters in the polluted environment.

2. Machine Design (4 ECTS)

Introduction into the complex process of building design and construction; enabling students to understand the logic of construction and its elements, requirements and factors, and the problems which professionals in interdisciplinary design and construction teams face in their everyday work. Enabling students to understand the area of activity and responsibilities of building design professionals(architects, civil engineers,…) Fundamentals of technical literacy: engineering drawing, graphical representations in building sciences and engineering: plan, section, elevation, three dimensional presentation; obligatory elements of these technical drawings: title, scale, orientation, authors' and company data; conventions concerning the purpose of small / large scale plans: situation plan, main design, construction designs, detail drawings, urban planning plans); conventional symbols for elements of a building (e.g. walls, windows, doors, stairs etc.), symbols for different materials and elements of utility systems; logic of numerical (metric) description. Different fields of construction: architecture, civil engineering, urban planning; their aim, logic, basic concepts. Considerations preceding the selection of a structure; material – structure – form – economic efficiency: different possible solutions, optimization; Methods and systems of construction (traditional, monolithic, and assembling). Basics of building science: properties of building materials, physics of buildings; thermal and moist insulation, noise protection, heating and cooling systems; economy and ecology of

construction: "ecologically sustainable building", alternative energy resources (e.g. solar energy). Function of a building; utility distribution main system; connecting different parts of a building horizontally and vertically; access to a building; connecting differential settlements; traffic in movement and standstill; urban infrastructure; bridges and viaducts; basic concepts and problems of urban and territorial planning; impact of buildings on environment.

3. Environmental Emissions (5 ECTS)

The objective of the course is to introduce a student with the environmental emissions issues caused by nature and anthropogenic activity.

Within lectures, the following will be delivered:

- Introduction and basic terms in the field of environmental emissions – EMISSION, ENVIRONMENT
- Basic constituents of the environment – AIR, WATER & SOIL
- Natural sources of environmental emissions
- Environmental emissions caused by anthropogenic activity
- Main sources of air, water and soil emissions: metallurgy, mineral sources industry, process chemical industry, wood etc.
- Air pollution problem solution for minimisation of solid particles and gaseous compounds emissions
- Global warming and greenhouses gasses
- The possibilities for greenhouses effect reduction
- Ozone holes
- Brief overview of wastewater treatment methods
- Introduction to soil remediation
- Mankind as direct source of environmental emissions
- Short overview of environmental protection – NATIONAL PARKS & PARKS OF NATURE

Seminars will include analysis of particular case studies as well as solving of simple problems from the field of environmental engineering.

Laboratory practicum will include introduction to the Gas Analyser 5000 and determination of parameters in the polluted environment.

4. Environmental Risk Assessment (4 ECTS)

The objective of the course is to introduce a student with the environmental risk assessment principles as well as to broaden the standard knowledge gained within this course on the application field of environmental protection.

Within lectures the following will be delivered:

- Introduction and definition of the terms hazard, risk, environmental risk assessment
- Examples of industrial accidents: Seveso (Italy), Bhopal (India), Chernobyl (Ukraine), Fukushima (Japan), Seveso II Directive
- Implementation of Seveso II Directive into Croatian legislation
- Quantitative and qualitative risk assessment
- Risk analysis and risk management

- Minimization risks goals „Carrot diagram“
- Tolerance area and risk minimisation measures
- Risk matrix
- Statistical risk analysis
- Event tree analysis
- Fault tree analysis
- Methods and environmental risk assessment
- Categories of consequences
- Categories of probabilities.

Seminars will include analysis of particular case studies from the field of environmental engineering.

5. Groundwater Protection (4 ECTS)

Introduction – The importance of groundwater; The link between groundwater pollution and the environment; Human impact on groundwater; Occurrences of groundwater.

Criteria for groundwater protection – Status of groundwater protection; The criteria for determining the protection zones; Methods of preparation expert background documents; Protection in Croatia; The experience of European countries.

Alluvial aquifers – Research methods; Types and mechanism of contaminations; The application of mathematical models; Examples of protection.

The protection of karst aquifers – Basic characteristics; Research Methods; Basic elements for evaluating natural vulnerability, hazard and risk assessment; Examples of protection.

Final overview – Application of GIS in groundwater protection. The decision-making system of groundwater protection.

6. Water Management (4 ECTS)

Lectures (30): Introduction (2). Water resources value - theoretical settings of the management systems (2). Water Framework Directive - the significance and objectives (2). CIS guidebooks - review (4). Management of surface waters: typology; status assessment (2). Groundwater management: Groundwater Directive - the significance and objectives; groundwater bodies; status and risk assessment (4). Management of transitional and coastal waters (2). Nitrates Directive - zones vulnerable to nitrates (2). Urban Waste Water Treatment Directive - eutrophic areas, sensitive areas (2). Croatian Water Act (2). Croatian Water Management Strategy: organization of water resources management in Croatia; coordination of administrative structure in the river basins; river basins features (4). River Basin Management Plan: the content of the plan; public relations (2); Transboundary aquifers - management and protection (2).

Exercises and seminars (15): Status and risk assessment of the groundwater bodies in Croatia (8). Preparation of seminars (5). Preliminary exam (2).

7. Hydrothermal Reservoirs (4 ECTS)

Lectures and exercises with a field triep: Fundamentals of underground heat transfer; thermal conditions inside the Earth and the Earth's crust,; continental plate tectonics (4L +2E). Conductive and

convective heat transfer, distribution and types of geothermal reservoirs (2L +1E). Hydrodynamic conditions in north-western Croatia on the example of Zagreb thermal aquifer (2L +1E). Gringarten form; analysis of geothermal energy reserves and recoverable reserves of deposits (2L +1E). Impact of corrosion and scaling in the pipeline system; techno-economic characteristics of geothermal reservoirs in Croatia (4L +2E). Fundamentals of using geothermal energy; Lindal diagram (4L +2E). Equipment of systems for direct use of geothermal energy and applications: greenhouses, fish farms, space heating in industry, propulsion of the low temperature Stirling engine (4L +2E). Geothermal heat pumps and borehole heat exchangers (GHP, DHE); conversion of geothermal energy into electrical energy: plants with dry or superheated steam, condensing process, steam separation plants, binary systems, combined process (4L +2E). Impact of geothermal energy on the environment (2L +1E). Overview of installed geothermal plants in Europe and worldwide (2L +1E).

8. Basic Principles of Waste Management (5 ECTS)

Students will gain knowledge of the basics on management of different types of waste including municipal waste and waste from various production processes and industries with which engineers face in professional work. Through this collegium will be analysed different segments of waste streams, such as the identification, waste characterization, methods of collection, treatment and disposal with an emphasis on environmental and economic aspects of waste management and with the application of the principles of waste management hierarchy.

9. Waste Management (4 ECTS)

Lectures (30): Introduction (2). Basic concepts of waste management (2). Design of waste management systems - integrated system elements, responsibilities, design process (2). Waste management centres - elements of the system (facilities), interrelationships, basic characteristics (2). Programmes for reduction of waste, tools for programme development, assessment of product lifecycle (2). Hazardous waste management - characteristics, quantities, types (4). Toxicity, sources (2). Treatment, storage, disposal of hazardous waste (2). Treatment of hazardous waste (physical-chemical treatment, remediation, solidification, thermal treatment) (2). Reducing the amount and hazardous properties of waste (2). Industrial waste management practices - chemical industry, refineries, metallurgical industry, power industry, food industry, pharmaceutical industry, waste management in harbours (4). Methodology for the development of basic waste characterization (4).

Exercise (15): Examination of typical practical examples related to lecture topics (15).
Seminar (15): Independent assignment (seminar essay) on topics related to waste management.

10. Soil Mechanics I (6 ECTS)

Physical characteristics of soils. Soil classification schemes. Flow of water through soil. Stress-strain relationship in soils and effective stresses. One-dimensional compression and consolidation settlement of fine-grained soils. Shear strength of soils. Bearing capacity of soils and settlement of shallow foundations.

11. Applied Statistics (5 ECTS)

Empirical Distributions: empirical data and statistical characteristics, frequency polygons, arithmetic mean, variance, moments;

Correlation and Regression: two-dimensional statistical characteristics scatter diagram, smallest square method, regression line, covariance, correlation coefficient, equation of variance analysis;

Probability: simple event and probability definition, algebra of events, independent events, conditional probability, Bayes formula; random variable: probability function, distribution function, expected value, variance, moments. Discrete random variable, Binomial distribution, Poisson distribution. Continuous random variable, Normal distribution, Logarithm-normal distribution, Gamma distribution;

Hypothesis Test: statistical hypothesis and testing, critical value and region of significant decreases, types of errors, χ^2 test, t Test, f Test;

Estimation of Distributions Parameters: sample, interval estimations of expected value and dispersion, preciseness and reliability of estimation, sample sizes.

Knowledge testing and examinations: Preliminary examination, written and oral examination

12. Geostatistics in Environmental Protection (4 ECTS)

Lectures (30) and exercises (15): Generally about geostatistics. History of geostatistics – assessment of ore body. Application of geostatistical methods in other areas and Environmental Engineering. (3+0); Generally about interpolation. Estimation of analysed parameter value at every point of the investigated area based on the known values at sampling points. Surfer 8 program. Review, analysis and comparison of interpolation methods and graphical interpretation of the spatial distzrinution of the analysed parameter. (3+0); Data base in Surfer 8. Spatial distribution model of analysed parameter by different interpolation methods. Iso line chart. (1+2); Estimation of interpolation method reliability. Cross validation procedure and estimate of error variance for each interpolation method for the same database. (1+2); Analysis and comparison of different interpolation methods models. Selecting the best interpolation method for a specific spatial distribution model based on cross validation results and graphical interpretation. (1+2); Geostatistics. Spatial correlation and regionalised variable. Characteristics of regionalised variable and impact range (neighbourhood). Comparison of statistics and geostatistics. Analysis of differences between statistics and geostatistics. (3+0); Variogram - basic tool of geostatistics. Definition of gamma function. Variogram as graphical presentation of gamma function. Basic components and characteristics of variogram; sill and range of variogram, shape of gamma function. Regionalised variable influence on gamma function and variogram characteristics. (3+0); Experimental variogram. Construction of simple experimental variogram. Correlogram. Construction of simple correlogram. Comparison of variogram and correlogram. (1+2); Lag and lag tolerance at experimental variogram. Influence of lag size on variogram shape. Construction of experimental variograms for same data by different lags and lag tolerances. (1+2); Theoretical variogram. Mathematical formula for gamma function inside research area and regionalised variable range. Characteristics of theoretical variogram. Fitting: selection of the best theoretical variogram for a specific experimental variogram. (2+1); Nugget effect. Cause of nugget effect. Influence of nugget effect on estimate of error. Definition of optimal value of fitted variogram parameters (range, nugget). (1+2); Kriging. Basic principles of kriging technics. Types of kriging. Selection of kriging type yielding the least estimate of error. (2+1); Anisotropy. Definition of anisotropy characteristics for research area. Definition of position of anisotropy axis. Variographic analysis by anisotropy axis. (2+1) Presentation and analysis of geostatistical method application in solving environmental engineering problems. (3+0); Presentation of students' seminar assignments. (3+0).

13. Dynamic and Groundwater Modelling (5 ECTS)

Lectures (30): Introduction and basic terms (1). Monitoring hydrological parameters (precipitation, surface water) (2). Groundwater monitoring (quantity and quality of water) (2). Sampling procedures in the unsaturated and saturated zones of the aquifer (exploration drilling, sampling techniques and conservation methods for solid, liquid and gaseous samples) (2). Groundwater monitoring at several levels of the aquifer (multilevel monitoring) (1). Aquifer monitoring design with different types of porosity (intergranular, fissure, fissure-cavernous porosity) (2). Design and installation of wells for groundwater monitoring in different aquifer types (2). Field equipment and instruments for measuring groundwater quantity and quality in situ and on-line (2). Determining the monitoring mode for different purposes (2). Water monitoring under the EU Water Framework Directive (1).

Auditory exercises (10): Hydrological analysis, interaction of surface water and groundwater - example of calculating water balance (1).

Examples of defining the observational network for groundwater monitoring in different types of aquifers (2). Methods and frequency of measurement and groundwater sampling depending on monitoring type and observed parameters - implementation of recommendations and regulations, best practice (2). Review of modern technology in groundwater monitoring and methods of processing monitoring results (2). Using the results of monitoring groundwater quantity and quality for various purposes - examples from practice (1). Quiz (2).

Seminars (5): Students are required to independently examine, using literature, a practical example of groundwater monitoring, and present it in ppt. form

14. Mathematics I (8 ECTS)

Real and complex numbers. Vectors in plane and space. Sequences and series. Functions and their graphs, Limits and continuity. Derivative: geometric and physical interpretation. Basic rules of differentiation. Applications of the derivative: rise and fall of a function, maxima and minima problems. Taylor polynomial. Indefinite integral and methods of integration. Definite integral, geometric, and mechanical applications.

15. Mathematics II (8 ECTS)

Real functions of several real variables. Partial derivatives and total differential. Taylor formula, Maxima and minima problems. Double and triple integrals, Fubini's theorem and change of variables formula, geometric and physical applications. Ordinary differential equations: examples and solution methods. Linear differential equations of second order. Algebra of matrices. Systems of linear equations. Gauss elimination.

16. Bachelor Thesis (5 ECTS)
17. Master Thesis (25 ECTS)