SEMESTER 1

Block A: Fundamentals

Integrated Pollution Control	
Instructor	Wolfgang Calmano
Course Format	Lecture
Period	Winter Semester
Prerequisites	Fundamentals in chemistry, biology, environmental engineering
Contents	- Ecological and Technological Concepts - Industrial Ecology - Inorganic Contaminants - Organic Contaminants - Air Pollution Control - Wastewater - Potable Water - Soil - Waste - Recycling
Reading Resources	Förstner, U.: Integrated Pollution Control. 505 p. Springer Berlin 1998 Jain, R.K., Aurelle, Y., Cabassud, C., Roustan, M., Shelton, S.P. (Eds.): Environmental Technologies and Trends – International and Policy Perspectives, 398 p. Springer Berlin 1997 Basic environmental technology : water supply, waste management, and pollution control, Jerry A. Nathanson; Script
Performance Record	Review on specific aspects within given themes using additional references and a oral examination
ECTS	2.0

Noise Control	
Instructor	Werner Leschnik
Course Format	Lecture
Period	Winter Semester
Prerequisites	None
Contents	- Fundamentals of sound and hearing - Noise rating and noise measurement - Noise control in buildings (airborne and structure born sound insulation, reduction of noise from building services) - Noise control in the urban environment (outdoor sound propagation, noise reduction measures) - Noise control in industry (indoor sound propagation, noise control of indoor noise sources)
Reading Resources	Environmental urban noise, Amando García. - Southampton [u.a.] : WIT Press [u.a.], 2001 Understanding active noise cancellation, Colin H. Hansen. - London [u.a.]: Spon, 2001 Anderson J.S., Bratos-Anderson M.: Noise – Its measurement, analysis, rating and control. Beranek L. L., Ver L. I.: Noise and vibration control engineering: Principles and application. Wilea, 1992. Maekawa Z., Lord P. : Environmental and architectural acoustics. E&F Spon, London, 1993.
Performance Record	Written or oral exam
ECTS	2.0

Environmental Analysis	
Instructor	Wolfgang Calmano, Holger Gulyas
Course Format	Lecture
Period	Winter Semester
Prerequisites	Fundamental knowledge of Environmental Aquatic Chemistry and Toxicology
Contents	- Mathematical and statistical evaluation of analytical methods - Sampling, sample preparation, error evaluation - Waste water analysis (inorganic and organic routine parameters) - Analytical spectroscopy (basics) - Atomic absorption spectroscopy - Analytical chromatography (basics) - Gas chromatography, ion exchange chromatography - Infrared spectroscopy
Reading Resources	Analysis of environmental pollutants : principles and quantitative methods, Poojappan Narayanan. - London: Taylor & Francis, 2003 Introduction to environmental analysis, Roger N. Reeve. – Chichester [u.a.] : Wiley, 2002 Standard Methods for the Examination of Water and Wastewater, 20th Edition, L.S. Clesceri, A.E. Greenberg, A.D. Eaton, eds., published by American Public Health Association, American Water Works Association and Water Environment Federation, 199
Performance Record	Oral exam
ECTS	2.0

Health-Safety and Environmental Management	
Instructor	Constantin Stephan
Course Format	Lecture
Period	Winter Semester
Prerequisites	Fundamental knowledge in management techniques
Contents	- From dilution and end-of-pipe technologies to integrated pollution control - How industrial behaviours can be influenced - Costs and benefits of HSE management systems - Elements of an environmental management system - ISO 14001, EMAS and Responsible Care - How to achieve legal compliance - Environmental performance evaluation - Reactive and proactive measures - Hazard, risk and safety - Risk management - Elements of an occupational health and safety management system - Crisis management
Reading Resources	Stephan, Constantin: Industrial health, safety and environmental management : an introduction, Münster : Verl.-Haus Monsenstein und Vannerdat, 2007 Occupational and environmental safety engineering and management, Hamid R. Kavianian http://www.inem.org/ (International Network for Environmental Management, B.A.U.M. Group)
Performance Record	Written exam
ECTS	2.0

Environmental Microbiology	
Instructor	Rudolf Müller
Course Format	Lecture
Period	Winter Semester
Prerequisites	Basic knowledge in biology and biochemistry

Contents	- Microbial Ecology
	- Detection of microorganisms
	- Disinfection and sterilization
	- Sources for environmental pollutants
	- Biodegradability tests
	- Toxicity, use and degradation of pollutants:
	  - Alkanes, alkenes, alkines
	  - Benzene, toluene, xylenes, cresols
	  - Polycyclic aromatic compounds
	  - Chlorinated aliphatic and aromatic compounds
	  - Sulfonated compounds
	  - Nitrated compounds
	- Enzymes involved in the degradation of pollutants
	- Plasmids involved in the degradation of pollutants
	- Construction of novel strains for the degradation of pollutants

Reading Resources	Brock Biology of Microorganisms, M.T. Madigan, J.M.Martinko, J.Parker (2003), Prentice Hall International, Inc. ISBN 0-13-066271-2 Praxis der Sterilisation, Desinfektion-Konservierung, K.-H. Wallhäußer (1984), Thieme Verlag ISBN 3-13-416303-9 Umweltchemikalien, R. Koch (1989), VCH-Verlag ISBN 3-527-26902-9 Bioremediation Engineering, J.T. Cookson (1995) ISBN 0-07-012614-3
Performance Record	Regular presence and a home work required. Written exam.
ECTS	2.0

Fundamentals of Fluid Mechanics	
Instructor	Erik Pasche
Course Format	Lecture
Period	Winter Semester
Prerequisites	None
Contents	For many environmental protection measures in water, good knowledge of flow processes are necessary. This lecture will present basic hydraulic processes in rivers and estuaries and focus on mathematical description. Special reference is given to flow situation in natural rivers and in the presence of vegetation.
Reading Resources	Script, Streeter (1997) Elementary Fluid Mechanics Ven te Chow: Open Channel Hydraulics
Performance Record	Exercises and written exam
ECTS	2.0

Block B Treatment Processes and Control: Module a

Wastewater Treatment Technologies I	
Instructor	Ralf Otterpohl
Course Format	Lecture and exercise
Period	Winter Semester
Prerequisites	basics in biological wastewater treatment
Contents	- types of clarification plants and their design - nitrification, denitrification and process design - more efficient biological elimination of phosphoric compounds and process design - design of activated sludge processes with elimination of nutrients (DWA A131) - basics of mathematic modelling and dynamic simulation - control systems for clarification plants
Reading Resources	Tchobanoglous, George, Wastewater engineering : treatment and reuse / Metcalf & Eddy, Inc. Boston, McGraw-Hill, 2003 Henze, M.: Wastewater treatment: Biological andchemical processes. Springer, Berlin. 2002
Performance Record	Written Exam
ECTS	4.0

Physico-chemical Water Treatment	
Instructor	Holger Gulyas
Course Format	Lecture
Period	Winter Semester
Prerequisites	Fundamentals in Chemistry and Physics
Contents	- Stripping - Evaporation - Wastewater Incineration - Wet Air Oxidation - Advanced Oxidation Processes
Reading Resources	Physical-Chemical Treatment of Water and Wastewater, A.P. Sincero, G.A. Sincero, CRC Press, Boca Raton 2003; Handbook of Separation Techniques for Chemical Engineers, P.A. Schweitzer, ed., McGraw-Hill, New York 1988 Perry´s Chemical Engineers´ Handbook, R.H. Perry, D.W. Green, J.O. Maloney, eds., McGraw-Hill, New York 1984 Chemical Engineering, Vol. 2, J.M. Coulson, J.F. Richardson, Pergamon Press, Oxford 1991 Ozone in Water Treatment, B. Langlais, D.A. Reckhow, D.R. Brink, eds., Lewis Publishers, Chelsea 1991
Performance Record	Oral exam
ECTS	2.0

Practical Course in Water and Wastwater Technology II	
Instructor	Holger Gulyas
Course Format	Practical laboratory course
Period	Winter Semester
Prerequisites	None
Contents	Laboratory training of typical routineously performed wastewater analyses, e.g. measurement of inorganic constituents in wastewaters by means of probes (pH, dissolved oxygen, conductivity), organic sum parameters (TOC, COD), determination of biomass
Reading Resources	Wastewater engineering : treatment and reuse, George Tchobanoglous. - 4. ed.. - Boston [u.a.] : McGraw-Hill, 2003 Wastewater treatment : biological and chemical processes, Mogens Henze. - 3. ed. - Berlin [u.a.] : Springer, 2002 Textbook available in the intranet
Performance Record	Reports about experiments
ECTS	2.0

Water Protection and Wastewater Management	
Instructor	Ralf Otterpohl
Course Format	Lecture and exercise
Period	Winter Semester
Prerequisites	basics in biological wastewater treatment
Contents	
Reading Resources	
Performance Record	Written exam
ECTS	4.0

Block B Treatment Processes and Control: Module b

Groundwater Engineering	
Instructor	Wilfried Schneider
Course Format	Lecture
Period	Winter Semester
Prerequisites	None
Contents	- Occurrence of groundwater - Principals of groundwater flow - Theory of solute transport - Analytical solutions of transport equation - Pumping tests - Well design and construction - Salt water intrusion - Case studies
Reading Resources	The handbook of groundwater engineering, Jaques Delleur Groundwater Engineering, Abdel Azis Kashef
Performance Record	Written Exam
ECTS	2.0

Geographical Information Systems (GIS) in Water Ressource Management	
Instructor	Erik Pasche
Course Format	Lecture and practical course
Period	Winter Semester
Prerequisites	None
Contents	This lecture gives an introduction into geographical data processing with special reference to the application in environmental engineering and water resources. The techniques of geographical information systems is explained and in computer pool rooms the students are instructed in the application of a Geographical Information System (GIS) to set up a GIS data model, to produce thematic maps and to process map overlays and digital terrain models.
Reading Resources	Script
Performance Record	Written exam and assignments
ECTS	2.0

Environmental Hydraulic Engineering	
Instructor	Erik Pasche
Course Format	Lecture
Period	Winter Semester
Prerequisites	This lectures requires good knowledge about Hydraulics
Contents	Based on hydraulics, this lecture introduces into the design of environmentally sustainable hydraulic structures in rivers and coastal zones, comprising ecologically oriented restoration of rivers, flood management structural flood protection and fishway design. It shows the important biological, ecological and landscape factors which need to be considered in river training, flood management and hydro power generation. It introduces into cost evaluation, benefit assessment and cost-benefit-calculation.
Reading Resources	Script Water resources engineering, David A. Chin; Hydraulic Engineering, John A. Roberson
Performance Record	Written exam and assignments
ECTS	2.0

Modelling of Flow in Rivers and Estuaries	
Instructor	Erik Pasche
Course Format	Lecture and Exercise
Period	Winter Semester
Prerequisites	This lectures requires good knowledge about Hydraulics
Contents	- Derivation and application of the St. Venant-Equation and 2-dimensional shallow water equation - Introduction in the Finite-Element Technique for solving the hydrodynamic models - Introduction in the turbulence theory and presentation of different analytical methods to quantify the turbulent shear stresses in 2d-models - training in the software-tools KALYPSO-WSPM und KALYPSO-1d2d - Illustration and Training the application at two specific examples of real rivers - Presentation of methods for data acquisition concerning flood plain topography, bathymetry, surface roughness and hydrological boundary conditions as well as calibration parameters.
Reading Resources	BWK (1999): Hydraulische Berechnung von naturnahen Fließgewässern, Merkblatt 1/BWK Pasche (2007): Mannings' versus Darcy Weisbach Law for Flood Modeling in Rivers, Proceedings IAHR, conference Venice Reddy, J.N. (2005): Introduction to the Finite Element Methods, McGrawl Hill Series of Mechanical Engineering.
Performance Record	Written exam and 4 approved homeworks
ECTS	4.0

Process Modelling of Water and Wastewater Treatment	
Instructor	Klaus Johannsen, Joachim Behrendt
Course Format	Lecture and Exercise
Period	Winter Semester
Prerequisites	None
Contents	conditioning, air-stripping, flocculation, filtration, adsorption, ion-exchange, membrane separation, activated sludge processes, biofilm processes
Reading Resources	Henze, Mogens (Seminar on Activated Sludge Modelling, ; Kollekolle Seminar on Activated Sludge Modelling, ;) Activated sludge modelling : processes in theory and practice ; selected proceedings of the 5th Kollekolle Seminar on Activated Sludge Modelling, held in Kollekolle, Denmark, 10 - 12 September 2001 Henze, Mogens: Activated sludge models ASM1, ASM2, ASM2d and ASM3 Henze, Mogens: Wastewater treatment : biological and chemical processes Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;): Fundamentals of biological wastewater treatment Rautenbach, Robert (Albrecht, R.;): Membrane processes Mulder, Marcel: Basic principles of membrane technology
Performance Record	Written exam
ECTS	4.0

Block B Treatment Processes and Control: Module c

Waste Resources Management	
Instructor	Ina Körner
Course Format	Lecture
Period	Winter Semester
Prerequisites	None
Contents	- Waste amount, types and composition - Collection, transport and storage of waste - Technology transfer - Life cycle analysis - Waste processing - Recycling of different waste fractions - Thermal waste treatment - Biological waste treatment - Agricultural waste and sewage sludge - Industrial and special wastes
Reading Resources	Handout with copies of the overheads of the lessons; on-line available via intranet; Bernd Bilitewski; Georg Härdtle; Klaus Marek (1997): Waste management. Springer, Berlin [u.a.], ISBN: 3-540-59210-5
Performance Record	Written exam
ECTS	2.0

Contaminated Sites and Landfilling	
Instructor	Ina Körner
Course Format	Lecture and exercise
Period	Winter Semester
Prerequisites	None
Contents	- Risk assessment, legal aspects - Natural Attenuation - Securing of abandoned landfills - Stabilisation, solidification - Soil vapor extraction - Soil washing - Thermal Treatment - Bioremedation - Groundwater Remedation
Reading Resources	Franzius, V.; Wolf, K.; Brandt, E. (Hrsg.): Handbuch der Altlastensanierung. 2. Auflage. C. F. Müller-Verlag, Heidelberg, 1995. Stegmann, Brunner, Calmano, Matz (2001): Treatment of contaminated soil. Springer-Verlag, Berlin, Heidelberg, New York, Förstner, U.: Integrated Pollution Control. 505 p. Springer Berlin 1998
Performance Record	Written exam
ECTS	4.0

Aerobic and Anaerobic Waste Treatment	
Instructor	Ina Körner
Course Format	Lecture and exercise
Period	Winter Semester
Prerequisites	
Contents	
Reading Resources	
Performance Record	Written exam
ECTS	4.0

SEMESTER 2

Block C: Module a

Surface Hydrology	
Instructor	Erik Pasche
Course Format	Lecture
Period	Summer Semester
Prerequisites	skills in the application of GIS
Contents	description of the physical processes which lead to runoff on the surface and rivers of natural and urban watersheds. Explanation of anthropogenic influcences on groundwater recharge, long-term flow regime and flood hydrographs. Introduction into the theory of hydrological modeling by rainfall-runoff models. Application of a complex rainfall-runoff-model including data inventary and preperation by GIS, model calibration and sensitivity study for the multi-parameter model. The lecture is closely related to the lecutre “Sustainable Water Management and Water Supply” in which Global aspects of water management, and the full cycle of water on the surface and groundwater is explained. However this lecture concentrates on the runoff-processes on the surface and upper soil layer and introduces in flood hydrology.
Reading Resources	Applied surface hydrology, Ödon Starosolszky. - Littleton, Colo. : Water Resources Publications, 1987
Performance Record	Written exams and exercises
ECTS	3.0

Water and Wastewater Systems in a Global Context	
Instructor	Ralf Otterpohl, Knut Wichmann
Course Format	Lecture and Exercise
Period	Summer Semester
Prerequisites	
Contents	
Reading Resources	Ujang, Z.: Municipal wastewater management in developing countries. London, IWA Publ. 2006 Mara, D.: Domestic wastewater treatment in developing countries. London, Earthscan, 2004 Winblad, U.; Simpson-Hébert, M (Edts.) (2004): Ecological Sanitation, SIDA, Stockholm (free download from www.ecosanres.org) ISBN 91 88714 98 5 www.ecosanres.org (Stockholm Environment Institute / SIDA) www.ecosan.org (IWA Specialist Group 'Resources orienten Sanitation') www.gtz.de/ecosan (GTZ-ecosan, Gesellschaft für technische Zusammenarbeit)
Performance Record	Written exam
ECTS	4.0

Hydrobiology	
Instructor	Ludwig Tent
Course Format	Lecture, excursion with exercise
Period	Summer Semester
Prerequisites	None
Contents	- Running and stagnant waters with their surroundings as living sphere for plants, animals and man. Natural situation and nowadays reality - Goals for future developments - Demands of nature to engineering projects like city planning, constructions like e.g. brigdes, advanced waste water treatment and river maintenance - Practical exercise to get to know characteristic organisms of running waters - Sediments: origin, characterisation, how to get rid of problems in an environ-mentally acceptable way - Restructuring of aquatic habitats, river restoration, rehabilitation of stagnant waters - Diffuse immissions, erosion, soil conservation = improvement of the health of waters - Social implications
Reading Resources	Reconstruction versus ecological maintenance - improving lowland rivers in Hamburg and Lower Saxony. - in: HANSEN, H.O. and B.L. MADSEN (eds.): River Restoration `96; Trout 2010 – Restructuring Urban Brooks with engaged Citizens. - in: Nijland, H. and M.J.R. Cals (eds.): River Restoration in Europe; Practical Approaches
Performance Record	Written exam
ECTS	2.0

Block C: Module b

Fundamentals of Environmental Aquatic Chemistry and Toxicology	
Instructor	Klaus Johannsen, Wolfgang Ahlf, Wolfgang Calmano
Course Format	Lecture
Period	Summer Semester
Prerequisites	None
Contents	- Chemistry of water treatment - Solubility of gases in water - Equilibrium with solid carbonates - Precipitation and dissolution - Oxidation and reduction - Environmental chemistry of water - Acids and bases - Sorption and soil chemistry - Inorganic and organic pollutants - Basics of biochemistry - Bioavailability of chemicals - Effects of pollutants - Basics of toxicology - Risk assessment
Reading Resources	
Performance Record	Written exam
ECTS	3.0

Practical Course in Water and Wastewater Technology I	
Instructor	Joachim Behrendt
Course Format	Practical course
Period	Summer Semester
Prerequisites	None
Contents	Determination of important process parameters: Measuring respiratory activities (endogenious respiration, influence of waste¬water concentration and inhibitor concentration). Measuring oxygen input in activated sludge (continuous method) and tap water (discontinuous method) Residual time distribution using tracers (fixed bed reactors). Filtration (surface filtration, filter- and filer pie resistance, chemical conden¬sation) Flotation (pressure release flotation, using conditioning agents, pH variation)
Reading Resources	Wastewater engineering : treatment and reuse, George Tchobanoglous. - 4. ed.. - Boston [u.a.] : McGraw-Hill, 2003 Wastewater treatment : biological and chemical processes, Mogens Henze. - 3. ed. - Berlin [u.a.] : Springer, 2002
Performance Record	Reports about experiments
ECTS	2.0

Environmental Geochemical Engineering	
Instructor	Joachim Gerth
Course Format	Lecture
Period	Summer Semester
Prerequisites	None
Contents	Geochemical Engineering makes use of optimised geochemical processes for the solution of environmental problems. Solution are based on neutralisation, breakdown, concentration for immobilisation, which serve to eliminate the pollutant, make it more manageable, or prevent its entry into the mobile phase. All of these solutions have their counterpart in nature, where many examples are found of high concentrations of potentially harmful substances. The advantages of this approach are that we can device low-cost technolgies, with least interference with nature. The application of geochemical engineering concepts requires a better understanding of our environment and its ongoing processes than is necessary for a conventional technologies.
Reading Resources	Wiedemeier, T.H. et al.: Natural attenuation of fuels and chlorinated solvents in the subsurface. Wiley, 1999. Appelo, C.A.J. and Postma, D.: Geochemistry, groundwater and pollution. A.A. Balkema, Rotterdam 1994.
Performance Record	Written exam
ECTS	2.0

Management of Environmental Quality	
Instructor	Walter Leal Filho
Course Format	Lecture
Period	Summer Semester
Prerequisites	None
Contents	- Environmental management systems - Environmental quality - Risks assessment - Eco-auditing & Life-cycle analysis - Environmental impact assessment , EMAS / ISO 14001, Environmental health and indicators simulations
Reading Resources	Leal Filho W. (ed) (1997). (ed) (1998) Interdisciplinary Perspectives in Environmental Engineering. Peter Lang Verlag, Frankfurt
Performance Record	Written exam and oral presentation
ECTS	2.0

Block C: Module c

Renewable Energy	
Instructor	Martin Kaltschmitt
Course Format	Lecture
Period	Summer Semester
Prerequisites	None
Contents	- Solar energy for heat and electricity production - Wind energy for electricity production - Hydropower for electricity production - Ocean energy for electricity production - Geothermal energy for heat and electricity production
Reading Resources	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Renewable Energy – Technology, Economics and Environment; Springer, Heidelberg, 2007
Performance Record	Written exam
ECTS	3.0

Sludge Treatment	
Instructor	Joachim Behrendt
Course Format	Lecture
Period	Summer Semester
Prerequisites	Fundamentals of municipal and industrial biological waste water treatment
Contents	Fundamentals of reactions: hydrolysis, acidification, generation of methan, microbiology, stoichiometry, thermodynamics, kinetics, single and double stage processes, stability of processes. Anaerobic treatment of waste water from food industry and pharmaceutical production: UASB reactor, application of immobilised organisms (fluidised system, anaerobic filter), conditioning of substrates before digestion, retention times, metabolic rates, gas production, Treatment of sewage sludge: Sludge generation and characteristics; thickening; dewatering; stabilisation, environmental conditions, processes; dehydration, incineration, acceleration of anaerobic digestion.
Reading Resources	Metcalf und Eddy: Wastewater engineering: treatment and reuse, McGraw-Hill, 2003 J. Malina, F. Pohland: Design of Anaerobic Processes for the Treatment of Industrial and Municipal Wastes. Technomic Publ. Co., Lancaster, Pa., USA, 1992
Performance Record	Written exam
ECTS	2.0

Thermal Waste Treatment Processes	
Instructor	Stefan Heinrich, Joachim Gerth
Course Format	Lecture and exercise
Period	Summer Semester
Prerequisites	Fundamentals of Waste Management
Contents	- Fundamentals of combustion - Process technology of waste incineration - Flue gas treatment - Pyrolysis - Thermochemical processing of waste with integrated smelting of slag and fly ash
Reading Resources	
Performance Record	Written exam
ECTS	4.0

Block C: Module d

Applied Groundwater Modelling	
Instructor	Wilfried Schneider
Course Format	Lecture
Period	Summer Semester
Prerequisites	Fundamental knowledge in groundwater engineering
Contents	Students will use numerical groundwater models on personal computers to solve the following practical case: - Interrelationship between boundary conditions and groundwater flow - Influence of heterogeneous conductivity on groundwater flow - Influence of interpolation methods for parameter distributions - Influence of rivers on flow and solute transport - Water budgets analysis - Multilayer models and transient flow - Evaluation of remediation methods
Reading Resources	Applied groundwater modelling : simulation of flow and advective transport, Mary P. Anderson. - San Diego, Calif. [u.a.] 1992 3D-groundwater modelling with PMWIN : a simulation system for modelling groundwater flow and pollution, Wen-Hsing Chiang. 2001
Performance Record	Written exam
ECTS	3.0

Environmental Assessment	
Instructor	Martin Kaltschmitt
Course Format	Lecture and exercise
Period	Summer Semester
Prerequisites	
Contents	
Reading Resources	
Performance Record	Written exam
ECTS	4.0

Methods of Technology Assessment	
Instructor	Thomas Malsch
Course Format	Lecture
Period	Summer Semester
Prerequisites	None
Contents	The lecture deals with conceptual foundations and case studies of selected methods of technology assessment. The single topics are: Main concepts and selected methods of Technology Assessment (TA) Management of technology – Problems and prospects Sociological contributions to risk analysis Environmental Mediation Procedures Technological forecasting (e.g. Delphi technique) Futures studies (e.g. Scenario technique)
Reading Resources	Ernest Braun: Technology in Context: Technology Assessment for Managers, London, New York 1998 Joseph P. Martino: Technological forecasting for decision making. 1993 Alan L. Porter, Frederick A. Rossini, Stanley R. Carpenter, A. T. Roper et al.: A Guidebook for Technology Assessment and Impact Analysis. Series Volume 4. New York, Oxford 1980 Verein Deutscher Ingenieure (VDI): Technology Assessment: Concepts and Foundations (VDI Guideline 3780), Düsseldorf 2000
Performance Record	Oral presentation and written research paper
ECTS	2.0

SEMESTER 3

Block D: Module a: Sustainable Water Management and Ecological Sanitation in Developing Countries

Environmental Techniques in Rural Areas	
Instructor	Uwe Neis, Knut Wichmann
Course Format	Lecture
Period	Winter Semester
Prerequisites	Fundamentals in Sanitary Engineering
Contents	- Appropriate techniques and solutions for water supply and waste water disposal and treatment - Planning of irrigation - Health & Sanitation - Water resources & storage of water - Appropriate water treatment methods - Decentralized sewerage systems - Close-to-nature treatment systems: ponds, wetlands - Community participation - Social implications
Reading Resources	Crites, R., Tchobanoglous, G.: Small and Decentralized Wastewater Management Systems. McGraw Hill, 1998 Metcalf&Eddy, Inc. Revised by Tchobanoglous, G.: Wastewater Engineering: Treatment, Disposal and Reuse, McGraw-Hill.
Performance Record	Written exam
ECTS	2.0

Resources oriented Sanitation: Principles, Practice and Implementation of High – and Low-Tech Options	
Instructor	Ralf Otterpohl, Holger Gulyas
Course Format	Lecture
Period	Winter Semester
Prerequisites	None
Contents	- Material flows in domestic wastewater - Fertilising substances in human excreta - What is the aim of Ecological Sanitation (Source Control Sanitation) - Benefits of source separation in sanitation - Comments on conventional sanitation - Low-cost black water treatment technologies - Low-cost systems with urine-diversion - Greywater treatment - Rainwater – Harvesting and infiltration
Reading Resources	Scripts “Basics of Ecologicals sanitation”, “Comments on Conventional Sanitation”, “Interaction of industrial and municipal wastewater management”, and “Low-cost elements of Ecological Sanitation” Esrey, S.A., Andersson, I. Hillers, A., and Sawyer, R. (2001) Closing the loop. Ecological sanitation for food security. Swedish International Development Cooperation Agency; available at: www.ecosanres.org/PDF%20files/closing-the-loop.pdf Esrey, S.A., Gough, J., Rapaport, D., Sawyer, R., Simpson-Hébert, M., Vargas, J., and Winblad, U. (1998) Ecological sanitation. Swedish International Development Cooperation Agency; available at: www.ecosanres.org/PDF%20files/Ecological%20Sanitation.pdf
Performance Record	Oral exam
ECTS	4.0

Low-cost procedures for Water and Wastewater Analysis	
Instructor	Holger Gulyas
Course Format	Lecture and practical course
Period	Winter Semester
Prerequisites	Course “Environmental Analysis”
Contents	- On-site measurement of hygienic parameters - Nutrient analyses by reflectometric method - Oxygen uptake rate as parameter for toxicity toward bacteria - Absorbance at 254 nm as substitute for the organic sum parameters COD and TOC - COD cuvette tests - Conductivity - Alkalinity
Reading Resources	Script
Performance Record	Oral exam
ECTS	2.0

Sustainable Water Management and Water Supply	
Instructor	Knut Wichmann
Course Format	Lecture and Exercise
Period	Winter Semester
Prerequisites	None
Contents	- Global water problems – case studies - Syndromes of global change - Sustainable water management - Modelling and system analysis: water balances, mass balances, use of criteria/indicators in water resources management, Multicriteria Decision Making - Water resources management in Germany - The European Water Framework Directive - Environmentally sound technologies (ESTs)
Reading Resources	Script Principles of water resources : history, development, management, and policy, Thomas V. Cech. - New York : Wiley, 2003
Performance Record	Written exam
ECTS	3.0

Trends in Sustainable Water Strategies	
Instructor	N.N.
Course Format	Exercise
Period	Winter Semester
Prerequisites	None
Contents	Students will learn how to present research results
Reading Resources	
Performance Record	20 min oral presentation of the contents of a recently published article
ECTS	1.0

Block D: Module b: Bioengineering

Practical Course in Aquatic Chemistry	
Instructor	Wolfgang Calmano
Course Format	Practical course
Period	block, 1 week at the end of winter term
Prerequisites	Course “Environmental Aquatic Chemistry and Toxicology”
Contents	- precipitation, flocculation, coagulation - oxidation kinetics of Fe(II) - spectrophotometrical determination of complex stoichiometry of metals - polarographical and voltammetrical determination of heavy metal stability constants
Reading Resources	Aquatic environmental chemistry, Alan G. Howard. - Oxford [u.a.] : Oxford University Press, 1998 Aquatic chemistry: chemical equilibria and rates in natural waters, Werner Stumm. - 3. ed. - New York, NY [u.a.] : Wiley, 1996
Performance Record	Oral exam
ECTS	4.0

Technical Biology	
Instructor	Wolfgang Ahlf
Course Format	Lecture
Period	Winter Semester
Prerequisites	None
Contents	- Principles of cell biology - Nutrition and growth of bacteria - Bacterial examination of environmental media - Microbiological and ecological aspects of wastewater and sludge treatment processes - Biofilms - Technical implications of biofilms
Reading Resources	Script Technische Biologie und Bionik 2, Werner Nachtigall. – Stuttgart [u.a.] : G. Fischer, 1995
Performance Record	Written exam
ECTS	1.0

Trends in Water Research	
Instructor	N.N.
Course Format	Exercise
Period	Winter Semester
Prerequisites	None
Contents	Students will learn how to present research results
Reading Resources	
Performance Record	20 min oral presentation of the contents of a recently published article
ECTS	1.0

Technical and Environmental Microbiology Practical Course	
Instructor	Garabed Antranikian, Rudolf Müller
Course Format	Practical course and lecture
Period	Winter Semester
Prerequisites	fundamental knowledge in Microbiology
Contents	- Handling of micro-organisms under aerobic and anaerobic conditions - Determination of micro-organisms in soil, water and air - Pure cultures - Growth kinetics - Production and determination of technical enzymes
Reading Resources	Süßmuth, R.; Eberspächer, J.; Haag, R.; Springer, W.: Biochemisch-mikrobiologisches Praktikum. Thieme Verlag, Stuttgart. Schlegel, H. G.: Allgemeine Mikrobiologie. Georg Thieme Verlag, Stuttgart, New York, 5. Auflage, 1981. Drews, D.: Mikrobiologisches Praktikum. Springer Verlag, Berlin, Heidelberg, New York, 3. Auflage, 1976. Gottschalk, G.: Bacterial Metabolism. Springer Verlag, New York, Berlin, Heidelberg, Tokyo, 2nd Edition, 1988.
Performance Record	Protocols
ECTS	2.0

Energy from Biomass	
Instructor	Martin Kaltschmitt
Course Format	Lecture
Period	Winter Semester
Prerequisites	
Contents	- Biomass within the energy system - Biomass as a source of energy - Thermo-chemical conversion - Combustion - Gasification - Char coal production - Physical-chemical conversion - Bio-chemical conversion - Biogas - Bioethanol
Reading Resources	Kaltschmitt, M.; Hartmann, H. (Hrsg.): Energie aus Biomasse; Springer, Berlin, Heidelberg, 2001
Performance Record	Oral exam
ECTS	3.0

Technical Microbiology	
Instructor	Garabed Antranikian
Course Format	Lecture
Period	Winter Semester
Prerequisites	fundamental knowledge in Microbiology or Biology
Contents	- History of microbiology and biotechnology - Structure and function of microbial cells: morphology, cell membranes, cell wall, storage compounds, spore formation, transport processes. - The genetic material: translation, transcription, protein synthesis and export. - Structure and function of proteins. - Taxonomy of microorganisms including bacteria, archaea and eukarya. - Pathogenic and nonpathogenic microorganisms. - Diversity of viruses, structure and function. - Physiology: cultivation of aerobic and anaerobic microorganisms. - Medium requirements and substrate utilization and transport. - Batch and continuous cultures. - Nitrogen and carbon cycles. - Metabolic pathways in microorganisms: Aerobic and anaerobic pathways, yeast and Pasteur effect. - Phototrophic bacteria, chemolithotrophs and methanogens. - Significance of microorganisms for the industry including food, feed, chemical, pharmaceutical industries and medicine. - Fermentation and the production of solvents, alcohols, acids and gases. - Production of citrate, amino acids and vitamins. - Use of enzymes for various industrial applications. Biocatalysis and formation of high value products.
Reading Resources	Lengeler, Drews, Schlegel: Biology of the Prokaryotes. Thieme Verlag, Stuttgart, New York, 1999. Rehm, H. J.: Industrielle Mikrobiologie. Springer Verlag, Berlin, New York u.a. 2. Auflage, 1980. Brock T. D.; Madigan M. T.: Biology of Microorganisms. Prentice-Hall International Editions, 5th Edition, 1984.
Performance Record	Written exam
ECTS	2.0