

Environmental engineering examinations

2018 SYLLABUS

Group A - Compulsory examinations (six required)

18-Env-A1 Principles of Environmental Engineering

Population, economic growth, industrialization, urbanization and energy-use, as causes of environmental pollution. Mass and energy balance for environmental engineering systems under steady state and unsteady state conditions. Physical and transport properties of homogeneous and heterogeneous mixtures. Contaminant partitioning and transport in air, water and solids. Characteristics of particles, chemistry of solutions and gases, material balances, reaction kinetics, microbiology and ecology, as related to the environment. Application of environmental principles (technical and non-technical) to: water resource management, water and wastewater treatment, air pollution control, solid waste management, environmental impact assessment, and environmental ethics. Thermal pollution, noise pollution, greenhouse effect, acid precipitation, ozone depletion, air toxics, and ground-level ozone and fine particulates (photochemical smog). Sustainable development, life cycle analysis, and principles of environmental quality objectives, standards and guidelines. Soils as a treatment system.

ADD

Textbooks (most recent edition is recommended):

- Ni-Bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, published: October 26th 2010, ISBN 9780071630054
- Edward S. Rubin, Introduction to Engineering and the Environment, published: November 30th 2000, ISBN: 9780072354676
- David Cornwell, Mackenzie Davis, Introduction to Environmental Engineering, McGraw-Hill Education, January 31st 2012 - 1056 pages.
- Kiely, G., Environmental Engineering. McGraw Hill, 1996. ISBN: 007091272

18-Env-A2 Hydrology and Municipal Hydraulics Engineering

Components and processes of natural hydrologic systems. Precipitation and snow melt, runoff, infiltration, storm frequency and duration analysis, conceptual models of runoff, stream flow and hydrograph analysis, frequency and probability with application to precipitation, floods and droughts; evaporation and evapotranspiration. Hydraulics of closed pipe systems and open channel flow

including flow under uniform and gradually varied conditions, sediment transport. Water distribution systems, storage reservoirs and wastewater collection systems, pipe networks and network design, sanitary sewer and storm water collection system design, basic pumps/prime movers, urban drainage and runoff control. Climate change, its impact on the design of drainage systems and the need for integration of ecological considerations.

ADD

Textbooks (most recent edition is recommended):

- N/A Water Environment Federation, N/A American Society of Civil Engineers/ Environmental & Water Resources Institute, Design of Urban Stormwater Controls, MOP 23, published: May 8th 2012 ISBN: 9780071704441
- N/A Water Environment Federation, Prevention and Control of Sewer System Overflows, 3e - MOP FD-17, published: July 19th 2011, ISBN: 9780071738606
- Wanielista, M., Kersten, R., and R. Eaglin. Hydrology: Water Quantity and Quality Control. Wiley Interscience, 1996. ISBN: 0471072591
- Zipparro, V.J., Davis' Handbook of Applied Hydraulics Fourth Edition. McGraw Hill, 1993. ISBN: 0070730024
- Franzini, J., Freyberg, D., Linsley, R., and G. Tchobanoglous, Water Resources Engineering. McGraw Hill, 1991. ISBN: 0070380104

18-Env-A3 Geotechnical and Hydrogeological Engineering

Soil composition, properties, identification and classification. Particle size distribution. Seepage and permeability. Concepts of pore water pressure and effective stress. Compressibility. Capillary pressure and hydraulic head. Principles of effective stress, stress-deformation and strength characteristics of soils, consolidation, compaction, slope stability, infiltration, stress distribution with soils and settlements.

Fundamental physics and properties of groundwater flow in porous geologic material; anisotropy, heterogeneity. Introduction to the theory of groundwater flow; groundwater flow equations and patterns, recharge and discharge, flow nets, aquifer pumping, two-phase flow, well hydraulics and non-aqueous phase liquids. Numerical modeling concepts. Aquifer development and management. Wellhead protection. Impact of surface activities and over pumping on aquifer quality.

ADD

Textbooks (most recent edition is recommended):

- Cernica, J.N., Geotechnical Engineering: Soil Mechanics. Wiley Interscience, 1995. ISBN: 0471308846
- Fredlund, D.G. and H. Rahardjo., Soil Mechanics for Unsaturated Soils. Wiley Interscience, 1993. ISBN: 047185008X
- Spitz, K. and J. Moreno., A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience, 1996. ISBN: 0471136875
- LaMoreaux, P.E., and LaMoreaux, J.W., Environmental Hydrogeology. Lewis Publisher, 1997. ISBN: 0873719492

18-Env-A4 Water and Wastewater Engineering

Characteristics of water: physical, chemical and biological parameters, standard methods of water analyses, impact in streams and treatment of urban and agricultural runoff, population forecasting, prediction of water demand and wastewater generation, water and wastewater quality, water and wastewater treatment plants and systems: physical, chemical and biological systems, primary, secondary and tertiary treatment, sedimentation, coagulation, flocculation, filtration, adsorption, ammonia removal, aeration, anaerobic and aerobic digestion, activated sludge and trickling filter, ion exchange, lagoons, disinfection, natural treatment systems, sludge treatment and disposal, industrial wastewater treatment: characteristics of industrial wastewater, treatment levels and available technologies. Design of isolated wastewater treatment systems. Emphasis on need to consider nutrient and heat recovery as well as impact of emerging contaminants and its implication for wastewater treatment plant design. **ADD**

Textbooks (most recent edition is recommended):

- N/A Metcalf & Eddy, Inc., George Tchobanoglous, H. David Stensel, Ryujiro Tsuchihashi, Franklin L. Burton, Wastewater Engineering: Treatment and Resource Recovery, published: September 3rd 2013, ISBN: 9780073401188
- N/A Water Environment Federation, Wastewater Treatment Process Modeling, Second Edition (MOP31), published: August 9th 2013, ISBN: 9780071798426
- E.W. Bob Boulware, Alternative Water Sources and Wastewater Management, published: September 11th 2012, ISBN: 9780071719513
- N/A Water Environment Federation, Safety Health and Security in Wastewater Systems, Sixth Edition, MOP 1, published: September 5th 2012, ISBN: 9780071780933
- N/A American Water Works Association, N/A American Society of Civil Engineers, Water Treatment Plant Design, Fifth Edition, Published: July 10th 2012, ISBN: 9780071745727

- Casey, T.J., Unit Processes in Water and Wastewater Engineering. Wiley Interscience, 1997. ISBN: 0471966932
- Weber, W.J. and DiGiano, F.A. Process Dynamics in Environmental Systems. Wiley Interscience. ISBN: 0471017116
- McCarty, P., and Rittmann, B., Environmental Biotechnology: Principles and Applications. McGraw-Hill, 2000. ISBN: 0072345535
- Metcalf & Eddy, Inc., Wastewater Engineering: Collection and Pumping of Wastewater. McGraw-Hill, 1981. ISBN: 007041680X
- Burton, F., Metcalf and Eddy Inc, Tchobanoglous, G., Wastewater Engineering: Treatment, Disposal and Reuse. McGraw Hill, 1991. ISBN: 0070416907
- Reed, S.C. and Crites, R.W., Natural Systems for Waste Management and Treatment. McGraw Hill, 1996. ISBN: 0071346627
- Eckenfelder, W.W. (Jr.), Industrial Water Pollution Control, (2nd Ed). McGraw-Hill, 1989. ISBN: 007018903X.
- Guyer, H.H., Industrial Processes and Waste Stream Management. Wiley Interscience, 1998. ISBN: 0471299847.
- Bishop, P., Pollution Prevention: Fundamentals and Practice. McGraw Hill, 2000. ISBN: 0073661473
- American Water Works Association, Water Treatment Plant Design, (3rd Ed.). McGraw-Hill, 1997. ISBN: 0070016437.
- American Water Works Association, Water Quality and Treatment: A Handbook of Community Water Supplies. McGraw Hill, 1998. ISBN: 0070015406
- Kawamura, S., Integrated Design and Operation of Water Treatment Facilities. Wiley and Sons, 2000. ISBN: 0471350931
- Nyer, E.K., Groundwater Treatment Technology, (2nd Ed.). Wiley Interscience, 1992. ISBN: 0471284149.
- R.L. Droste, Wiley, Theory and Practice of Water and Wastewater Treatment, 1997.

18-Env-A5 Air Quality and Pollution Control Engineering

Sources and classification of atmospheric pollutants, indoor and outdoor air pollutants, health and ecological impacts, meteorology: influence of solar radiation and wind fields, lapse rate and stability conditions, characteristics of stack plumes, Dispersion and deposition modeling of atmospheric pollutants: Eddy and Gaussian diffusion models, Puff models, effective stack heights and spatial

concentration distributions, Measurement techniques. Characteristics of various air pollutant particulates, health and nuisance/aesthetic considerations (PM_{2.5} and PM₁₀) and gaseous pollutants (CO, SO_x, NO_x, etc.), their behaviour in the atmosphere, monitoring. Control of particulates: collection mechanisms and efficiencies. Control of gases and vapours: adsorption, absorption, combustion, incineration. Control of sulphur oxides and oxides of nitrogen, desulphurisation, kinetics of NO_x formation. Photochemical reactions, role of nitrogen and hydrocarbons in photochemical reactions, air toxics, mobile sources of air pollutants, noxious pollutants, and odour control. Emissions trading.

Olfactometry as a method of measuring odours; its science and application.

ADD

Textbooks (most recent edition is recommended):

- Alley, E.R, Stevens, L.B., and Cleland, W. L., Air Quality Control Handbook. McGraw-Hill, 1998. ISBN: 0-07-001411-6.
- Buonicore, A.J. (ed) and W.T. Davis (ed), Air Pollution Engineering Manual. Air & Waste Management Association. Wiley-Interscience, 1992. ISBN: 0-471-28441-6.

18-Env-A6 Solid Waste Engineering and Management

Engineering design and operational aspects of waste generation, collection, storage, transfer, processing, including composting of organic waste, treatment and disposal. Engineering evaluation of: integrated waste management, solid waste characterization and classification, reduction, reuse and recycling, resource recovery and utilization. Life cycle assessment of waste, physical and chemical treatment methods and composting. Landfill design and operation including: site selection, engineered sites, liners and covers, leachate control and treatment, gas recovery and control, including utilization of recovered gas (energy), and landfill monitoring and reclamation.

Textbooks (most recent edition is recommended):

- Franchetti, Matthew J., Solid Waste Analysis and Minimization: A Systems Approach, May 27th 2009, ISBN: 9780071605243
- Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience, 1994. ISBN 0-471-30681-9.
- Sharma, H.D., and Lewis, S.P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.

Group B - Optional examinations (three required)

18-Env-B1 Environmental Assessment and Management Systems

Applicable federal and provincial environmental regulations. Analysis of environmental impact using technical and non-technical parameters. Environmental impact assessment legislation and regulatory framework. Environmental impact assessment applied to solid and liquid waste management, effluent control, air pollution control, urban development, and transportation systems. Environmental audits. Introduction to geographical information systems (GIS). Environmental management systems (EMS) ISO 14000/14001 standards, and applications. Principles of sustainable development and implications of finite biosphere and complexities for engineering design and decision-making. Design of controlled environments to enhance health and protection of natural resources for sustainable development. Resource problems and design with ecological, economic, demographic and social dimensions. Techniques to integrate knowledge and define policy. Risk analysis. Life cycle analysis. Risk management. Environmental impact assessment methods.

ADD

Textbooks (most recent edition is recommended):

- Canter, L., Environmental Impact Assessment. McGraw Hill, 1996. ISBN: 0070097674
- Bartell, S., Kolluru, R., Pitblado, R., and Stricoff, S., Risk Assessment and Management Handbook: For Environmental, Health and Safety Professionals. McGraw Hill, 1996. ISBN: 0070359873
- Lerch, I. And Paleologos, E., Environmental Risk Analysis. McGraw Hill, 2001. ISBN: 0071372660
- McGraw, D., Environmental Auditing and Compliance Manual. Wiley Interscience, 1993. ISBN: 0471285854
- Woodside, G. Yturri, J. and Aurriacho, P., ISO 14001 Implementation Manual. McGraw Hill, 1998. ISBN: 0070718520
- Curran, M., Environmental Life-Cycle Assessment. McGraw Hill, 1996. ISBN 007015063X
- Dorf, R.C., Technology, Humans and Society: Toward a Sustainable World. Academic Press, 2001. ISBN: 0122210905
- Pearce, D. and Barbier, E., Blueprint for a Sustainable Economy. Earthscan Publications, 2000. ISBN: 1853835153

18-Env-B2 Water Resources

Nature and response of waste inputs to water systems, point and non-point source loading rates. River flow and reservoir analysis. Availability of groundwater resources. Diffusion, dispersion and

pollutant transport mechanisms, including two phase flow. Eutrophication reduction in natural water systems. Contaminant decay modeling. Oxygen sag equation and modifications, water quality and contaminant transport in rivers. Functions of watershed models for hydraulic design, environmental assessment and flood warning. Global and national water problems, laws and legislation. Water resources and sustainable development. Technology and impacts of water conservation practices and policies on municipal service infrastructure. Storm water models and management systems. Impact of climate change on water availability. **ADD**

Textbooks (most recent edition is recommended):

- Mays, L., Water Resources Handbook. McGraw Hill, 1996. ISBN: 0070411506
- Biswas, A., Water Resources: Environmental Planning, Management, and Development, McGraw Hill, 1997. ISBN 0070054835
- Ward, R.C., Loftis, J.C. and McBride, G.B., Design of Water Quality Monitoring Systems. Wiley Interscience, 1990. ISBN: 0471283886
- Veissman, W. and Hammer, M., Water Supply and Pollution Control (6th Ed.) Addison Wesley, 1998. ISBN: 032101460X

18-Env-B3 Contaminant Transport

Major types of contaminants in air, surface water and ground water. Physical phenomena governing the transport of contaminants in different environments: advection, dispersion, diffusion, sorption, ion exchange, precipitation, dissolution, volatilization, equilibrium partitioning of contaminants amongst air, water, soil, sediments and biota. Development of governing transport equations, initial and boundary conditions, completely mixed and plug flow systems. Analytical and numerical solutions, model development, calibration, verification, sensitivity analysis, prediction and post audit.

Textbooks (most recent edition is recommended):

- Fetter, C.W., Contaminant Hydrogeology. 2nd Ed., Prentice Hall, 1998.
- Schnoor, J.L., Environmental Modeling: Fate of Chemicals in Water, Air and Soil. John Wiley & Sons, New York, 1996
- Wark, K., C.F. Warner and W.T. Davis, Air Pollution: Its Origin and Control. Addison and Wesley, 1998.

- Zheng, C. and G. D. Bennett, Applied Contaminant Transport Modeling, Theory and Practice. Van Nostrand Reinhold, New York, 1995.
- Chapra, Steven, Surface Water Quality Modelling, December 31st, 2008, Waveland Press Inc., Long Grove Illinois, USA, ISBN: 978-1577666059.

18-Env-B4 Site Assessment and Remediation

Introduction to engineering, regulatory and management aspects of site assessments and restoration. Fundamentals and interactions between soils, groundwater, contaminants, and microorganisms. Site characterization and investigations. Monitoring and sampling strategies and techniques. Remedial action screening. Engineered solutions for site remediation including: physical, chemical, biological and in-situ and ex-situ techniques. Risk assessment. Brownfields. Computer modeling for assessment and remediation.

Textbooks (most recent edition is recommended):

- Ewels, J., Bioremediation Principles. McGraw Hill, 1998. ISBN: 0070577323
- Lerch, I. And Paleologos, E., Environmental Risk Analysis. McGraw Hill, 2001. ISBN: 0071372660
- Spitz, K. and Moreno, J., A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience, 1996. ISBN: 0471136875
- Cookson, J.T., Jr., Bioremediation Engineering - Design and Application. McGraw-Hill, New York, NY, 1995.
- Ott, W., Environmental Statistics and Data Analysis. Lewis Publishers, 1994. ISBN: 0873718488

18-Env-B5 Industrial & Hazardous Waste Management

Definition and characteristics of industrial and hazardous wastes. Industrial and hazardous waste generation rates and prevention. Introduction to I&H waste collection, transportation, treatment, monitoring, and disposal. Applicable international, federal and provincial regulations and initiatives. Municipal services and planning associated with industrial and hazardous waste management. Physical, chemical and biochemical treatment technologies, and disposal methods, including landfilling and incineration. Environmental impact of industrial and hazardous waste management. Radioactive, nuclear and biomedical waste.

Textbooks (most recent edition is recommended):

- Freeman, H.M., and Harris, E.F., Hazardous Waste Remediation—Innovative Treatment Technologies. Tecnomomic Publishers Lancaster P.A., 1995.
- Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience 1994. ISBN: 0-471-30681-9.
- Sharma, H.D., and Lewis, S.P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.
- Bellandi, R. (ed), Hazardous Waste Site Remediation: The Engineer's Perspective. Wiley Interscience, 1995. ISBN: 0471286931.

18-Env-B6 Agricultural Waste Management

Agricultural sources of pollution (pesticides, mineral fertilizers, on-farm crop and food processing wastes and livestock wastes, wastewaters and waste seepages) and their effect on the total environment. Physical, chemical and biological properties of agricultural waste materials. Design of storage and handling systems for agricultural wastes. Physical, chemical and biological treatment processes of agricultural wastes, their life-cycle analysis, and their potential for nutrient recycling. Various methods of land application of agricultural wastes in relation to pollution problems and fertilizing value. Technologies for utilization of agricultural wastes for biogas production. Air pollution (noise, odour, dust); agriculture as carbon sink. Water quality parameters and management.

Textbooks (most recent edition is recommended):

REVISED. I GUESS THEY GOT TO 'SHIT' (AGRICULTURAL TERMINOLOGY) AND NEEDED TO CHANGE IT. NO APPARENT CHANGE IN SCOPE.

- Unger, P.W., Managing Agricultural Residues. Lewis Pub., 1994. ISBN: 0-873-71730-9.
- Loehr, Raymond, Pollution Control for Agriculture, ISBN: 978-0-12-455260-9.

18-Env-B7 Environmental Sampling and Analysis

Practical and essential principles of water, soil and air sampling. Basic concepts in quantitative analyses of physical, chemical, and biological parameters. Tolerable levels of contaminants in air, water and soil. Sampling, sample preparation and preservation techniques, and quality assurance and quality control. Development of optimum monitoring strategy, scheduling, and sampling frequency. Database management, data analysis, statistical treatment of data, sources of error, and seasonal effects. Instrumental methods of analysis for organic and inorganic contaminants in air, water, and soil: colorimetry, chromatography, spectroscopy, electrochemical probes, remote sensing and bioassays. Basic concepts of resolution, accuracy, precision, sensitivity, calibration and control of error.

Textbooks (most recent edition is recommended):

- Shugar, G.L., S.L. Bauman, D.A. Drum and J. Lauber, Environmental Field Testing and Analysis Ready Reference Handbook.
- Montgomery, D C, Design and Analysis of Experiments. (5th Ed.), Wiley, New York, 2000.
- Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada. Canadian Council of Ministers of the Environment The National Contaminated Sites Remediation Program March 1996.

18-Env-B8 Instrumentation and Process Control

Basic concepts of resolution, accuracy, precision, sensitivity, calibration and control of error. Analysis and interpretation of data. Transducers for the sensing of strain, displacement, velocity, acceleration, pressure, flow, temperature, humidity, moisture content, and electromagnetic radiation. Signal conditioning for noise reduction and control. Operational amplifiers. Systems for data acquisition, telemetry, display, recording and processing. Computer interfacing. Concept of transfer functions. Response of simple chemical processes to step, ramp, and sinusoidal inputs. Transient response of interacting elements in series. Frequency response analysis of simple systems. On-off control, proportional, integral, derivative, and combinations of these control actions. Feed-back and feed-forward control. Controller tuning and algorithms. Simple stability analysis. Dynamics and control of common chemical process units.

Textbooks (most recent edition is recommended):

- Nachtigal, C.L., Instrumentation and Control - Fundamentals and Applications. John Wiley & Sons, Inc., NY, 1990.

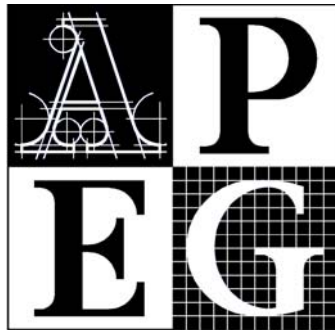
18-Env-B9 Environmental Chemistry and Microbiology

Chemistry of organic and inorganic contaminants in the environment. Natural chemical cycles in the biosphere, geosphere, hydrosphere and atmosphere, and consequences of anthropogenic disturbances. Chemical equilibrium and kinetics. Fundamentals of aquatic, atmospheric and soil chemistry. The fate of hazardous, refractory and heavy metal pollutants in the environment.

Introduction to microbial taxonomy, ecology and growth kinetics of microorganisms. The microbes of public health importance in water, soil and air, including their detection, occurrence, transport, and survival in the environment. Introduction to the application of different processes to remove contaminants in natural and engineered systems.

Textbooks (most recent edition is recommended):

- Evangelou, V.P. Environmental soil and Water Chemistry: Principles and Application. Wiley Interscience, 1998. ISBN: 0471165158
- Maier, R.M., Pepper, I. and Gerba, C. Environmental Microbiology. Academic Press, 2000. ISBN: 012497570-4
- McCarty, P., Parker G. and C. Sawyer, Chemistry for Environmental Engineering. McGraw Hill, 1994. ISBN: 0070549788
- Connell, D.W., Basic Concepts of Environmental Chemistry. Lewis Publishers, 1997. ISBN: 0873719980



Professional Engineers
and Geoscientists of BC

www.apeg.bc.ca

2004 ENVIRONMENTAL ENGINEERING SYLLABUS

and

Checklist for Self-Evaluation

APEGBC
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Burnaby BC V5C 6N2
Telephone: 604-430-8036
Fax: 604-430-8085
In Canada Toll-Free: 888-430-8035
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INTRODUCTION

Nineteen engineering disciplines are included in the Examination Syllabi issued by the Canadian Engineering Qualifications Board (CEQB) of the Canadian Council of Professional Engineers (CCPE).

Each discipline examination syllabus is divided into two examination categories, compulsory and elective. A full set of Environmental Engineering examinations consists of nine, three-hour examination papers. Candidates will be assigned examinations based on an assessment of their academic background. Examinations from discipline syllabi other than those specific to the candidate's discipline may be assigned at the discretion of the constituent Association/Ordre.

Before writing the discipline examinations, candidates must have passed, or have been exempted from, the Basic Studies Examinations.

The constituent Association/Ordre will supply information on examination scheduling, textbooks, materials provided or required, and whether the examinations are open or closed book.

NOTE TO CANDIDATES: THE LISTED TEXTBOOKS BELOW ARE ONLY SUGGESTED READING. THE LIST DOES NOT DEFINE OR LIMIT THE SYLLABUS.

ENVIRONMENTAL ENGINEERING

GROUP A

COMPULSORY EXAMINATIONS (SIX REQUIRED)

04-Env-A1 Principles of Environmental Engineering

Population, economic growth, industrialization, urbanization and energy-use, as causes of environmental pollution. Mass and energy balance for environmental engineering systems under steady state and unsteady state conditions. Physical and transport properties of homogeneous and heterogeneous mixtures. Contaminant partitioning and transport in air, water and solids. Characteristics of particles, chemistry of solutions and gases, material balances, reaction kinetics, microbiology and ecology, as related to the environment. Application of environmental principles (technical and non-technical) to: water resource management, water and wastewater treatment, air pollution control, solid waste management, environmental impact assessment, and environmental ethics. Thermal pollution, noise pollution, greenhouse effect, acid precipitation, ozone depletion, air toxics, and ground-level ozone and fine particulates (photochemical smog). Sustainable development, life cycle analysis, and principles of environmental quality objectives, standards and guidelines.

Suggested Text:

Kiely, G., Environmental Engineering. McGraw Hill, 1996. ISBN: 007091272

04-Env-A2 Hydrology and Municipal Hydraulics Engineering

Components and processes of natural hydrologic systems. Precipitation and snow melt, runoff, infiltration, storm frequency and duration analysis, conceptual models of runoff, stream flow and hydrograph analysis, frequency and probability with application to precipitation, floods and droughts; evaporation and evapotranspiration. Hydraulics of closed pipe systems and open channel flow including flow under uniform and gradually varied conditions, sediment transport. Water distribution systems, storage reservoirs and wastewater collection systems, pipe networks and network design, sanitary sewer and storm water collection system design, basic pumps/prime movers, urban drainage and runoff control.

WAS 98-ENV-A3, RENAMED, REWRITTEN

Suggested Texts:

NO CHANGE IN SCOPE

Wanielista, M., Kersten, R., and R. Eaglin.. Hydrology: Water Quantity and Quality Control. Wiley Interscience, 1996. ISBN: 0471072591

Zipparro, V.J., Davis' Handbook of Applied Hydraulics Fourth Edition. McGraw Hill, 1993. ISBN: 0070730024

Franzini, J., Freyberg, D., Linsley, R., and G. Tchobanoglous, Water Resources Engineering. McGraw Hill, 1991. ISBN: 0070380104

04-Env-A3 Geotechnical and Hydrogeological Engineering

**WAS 98-ENV-A4
REWRITTEN**

Soil composition, properties, identification and classification. Particle size distribution. Seepage and permeability. Concepts of pore water pressure and effective stress. Compressibility. Capillary pressure and hydraulic head. Principles of effective stress, stress-deformation and strength characteristics of soils, consolidation, compaction, slope stability, infiltration, stress distribution with soils and settlements.

Fundamental physics and properties of groundwater flow in porous geologic material; anisotropy, heterogeneity. Introduction to the theory of groundwater flow; groundwater flow equations and patterns, recharge and discharge, flow nets, aquifer pumping, two-phase flow, well hydraulics and non-aqueous phase liquids. Numerical modeling concepts. Aquifer development and management. Wellhead protection.

Suggested Texts:

Cernica, J.N., Geotechnical Engineering: Soil Mechanics. Wiley Interscience, 1995. ISBN: 0471308846

Fredlund, D.G. and H. Rahardjo., Soil Mechanics for Unsaturated Soils. Wiley Interscience, 1993. ISBN: 047185008X

Spitz, K. and J. Moreno., A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience, 1996. ISBN: 0471136875

LaMoreaux, P.E., and LaMoreaux, J.W., Environmental Hydrogeology. Lewis Publishers, 1997. ISBN: 0873719492

04-Env-A4 Water and Wastewater Engineering

**WAS 98-ENV-B3, 98-ENV-B4 & 98-ENV-B10
EXTENSIVE CHANGE (NEW)**

Characteristics of water: physical, chemical and biological parameters, standard methods of water analyses, biodegradable waste and agricultural runoff in streams, population forecasting, prediction of water demand and wastewater generation, water and wastewater quality, water and wastewater treatment plants and systems: physical, chemical and biological systems, primary, secondary and tertiary treatment, sedimentation, coagulation, flocculation, filtration, adsorption, ammonia removal, aeration, anaerobic and aerobic digestion, activated sludge and trickling filter, ion exchange, lagoons, disinfection, natural treatment systems, sludge treatment and disposal, industrial wastewater treatment: characteristics of industrial wastewater, treatment levels and available technologies.

Suggested Texts:

Casey, T.J., Unit Processes in Water and Wastewater Engineering. Wiley Interscience, 1997. ISBN: 0471966932

Weber, W.J. and DiGiano, F.A. Process Dynamics in Environmental Systems. Wiley Interscience. ISBN: 0471017116

McCarty, P., and Rittmann, B., Environmental Biotechnology: Principles and Applications. McGraw Hill, 2000. ISBN: 0072345535

Metcalf & Eddy, Inc., Wastewater Engineering: Collection and Pumping of Wastewater. McGraw-Hill, 1981. ISBN: 007041680X

Burton, F., Metcalf and Eddy Inc, Tchobanoglous, G., Wastewater Engineering: Treatment, Disposal and Reuse. McGraw Hill, 1991. ISBN: 0070416907

Reed, S.C. and Crites, R.W., Natural Systems for Waste Management and Treatment. McGraw Hill, 1996. ISBN: 0071346627

Eckenfelder, W.W. (Jr.), Industrial Water Pollution Control, (2nd Ed). McGraw-Hill, 1989. ISBN: 007018903X.

Guyer, H.H., Industrial Processes and Waste Stream Management. Wiley Interscience, 1998. ISBN: 0471299847.

Bishop, P., Pollution Prevention: Fundamentals and Practice. McGraw Hill, 2000. ISBN: 0073661473

American Water Works Association, Water Treatment Plant Design, (3rd Ed.). McGraw-Hill, 1997. ISBN: 0070016437.

American Water Works Association, Water Quality and Treatment: A Handbook of Community Water Supplies. McGraw Hill, 1998. ISBN: 0070015406

Kawamura, S., Integrated Design and Operation of Water Treatment Facilities. Wiley and Sons, 2000. ISBN: 0471350931

Nyer, E.K., Groundwater Treatment Technology, (2nd Ed.). Wiley Interscience, 1992. ISBN: 0471284149.

04-Env-A5 Air Quality and Pollution Control Engineering

**WAS 98-ENV-B1
REWRITTEN**

Sources and classification of atmospheric pollutants, indoor and outdoor air pollutants, health and ecological impacts, meteorology: influence of solar radiation and wind fields, lapse rate and stability conditions, characteristics of stack plumes, Dispersion and deposition modeling of atmospheric pollutants: Eddy and Gaussian diffusion models, Puff models, effective stack heights and spatial concentration distributions, Measurement techniques. Characteristics of various air pollutant particulates, health and nuisance/aesthetic considerations (PM_{2.5} and PM₁₀) and gaseous pollutants (CO, SO_x, NO_x, etc.), their behaviour in the atmosphere, monitoring., Control of particulates: collection mechanisms and efficiencies. Control of gases and vapours: adsorption, absorption, combustion, incineration. Control of sulphur oxides and oxides of nitrogen, desulphurisation, kinetics of NO_x formation. Photochemical reactions, role of nitrogen and hydrocarbons in photochemical reactions, air toxics, mobile sources of air pollutants, noxious pollutants, and odour control. Emissions trading.

Suggested Texts:

Alley, E.R, Stevens, L.B., and Cleland, W. L., Air Quality Control Handbook. McGraw-Hill, 1998. ISBN: 0-07-001411-6.

Buonicore, A.J. (ed) and W.T. Davis (ed), Air Pollution Engineering Manual. Air & Waste Management Association. Wiley-Interscience, 1992. ISBN: 0-471-28441-6.

04-Env-A6 Solid Waste Engineering and Management

**SPLIT FROM 98-ENV-B6
REWRITTEN**

Engineering design and operational aspects of waste generation, collection, storage, transfer, processing, including composting of organic waste, treatment and disposal. Engineering evaluation of: integrated waste management, solid waste characterization and classification, reduction, reuse and recycling, resource recovery and utilization. Life cycle assessment of waste, physical and chemical treatment methods and composting. Landfill design and operation including: site selection, engineered sites, liners and covers, leachate control and treatment, gas recovery and control, including utilization of recovered gas (energy), and landfill monitoring and reclamation.

Suggested Texts:

Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience, 1994. ISBN: 0-471-30681-9.

Sharma, H.D., and Lewis, S.P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.

GROUP B

ELECTIVE EXAMINATIONS (THREE REQUIRED)

04-Env-B1 Environmental Assessment and Management Systems

WAS 98-ENV-A6
EXTENSIVE EDITS

Applicable federal and provincial environmental regulations. Analysis of environmental impact using technical and non-technical parameters. Environmental impact assessment legislation and regulatory framework. Environmental impact assessment applied to solid and liquid waste management, effluent control, air pollution control, urban development, and transportation systems. Environmental audits. Introduction to geographical information systems (GIS). Environmental management systems (EMS) ISO 14000/14001 standards, and applications. Principles of sustainable development and implications of finite biosphere and complexities for engineering design and decision-making. Design of controlled environments to enhance health and protection of natural resources for sustainable development. Resource problems and design with ecological, economic, demographic and social dimensions. Techniques to integrate knowledge and define policy. Risk analysis. Life cycle analysis. Risk management.

Suggested Texts:

Canter, L., Environmental Impact Assessment. McGraw Hill, 1996. ISBN: 0070097674
Bartell, S., Kolluru, R., Pitblado, R., and Stricoff, S., Risk Assessment and Management

Hanbook: For Environmental, Health and Safety Professionals. McGraw Hill, 1996.
ISBN: 0070359873

Lerch, I. And Paleologos, E., Environmental Risk Analysis. McGraw Hill, 2001. ISBN:
0071372660

McGraw, D., Environmental Auditing and Compliance Manual. Wiley Interscience, 1993.
ISBN: 0471285854

Woodside, G. Yturri, J. and Aurricho, P., ISO 14001 Implementation Manual. McGraw Hill, 1998. ISBN: 0070718520

Curran, M., Environmental Life-Cycle Assessment. McGraw Hill, 1996. ISBN:
007015063X

Dorf, R.C., Technology, Humans and Society: Toward a Sustainable World. Academic Press, 2001. ISBN: 0122210905

Pearce, D. and Barbier, E., Blueprint for a Sustainable Economy. Earthscan Publications, 2000. ISBN: 1853835153

04-Env-B2 Water Resources **RENAMED, REWRITTEN**

Nature and response of waste inputs to water systems, point and non-point source loading rates. River flow and reservoir analysis. Availability of groundwater resources. Diffusion, dispersion and pollutant transport mechanisms, including two phase flow.

Eutrophication reduction in natural water systems. Contaminant decay modeling. Oxygen sag equation and modifications, water quality and contaminant transport in rivers. Functions of watershed models for hydraulic design, environmental assessment and flood warning. Global and national water problems, laws and legislation. Water resources and sustainable development. Technology and impacts of water conservation practices and policies on municipal service infrastructure. Storm water models and management systems.

Suggested Texts:

Mays, L., Water Resources Handbook. McGraw Hill, 1996. ISBN: 0070411506
Biswas, A., Water Resources: Environmental Planning, Management, and Development, McGraw Hill, 1997. ISBN 0070054835

Ward, R.C., Loftis, J.C. and McBride, G.B., Design of Water Quality Monitoring Systems. Wiley Interscience, 1990. ISBN: 0471283886

Veissman, W. and Hammer, M., Water Supply and Pollution Control (6th Ed.) Addison Wesley, 1998. ISBN: 032101460X

04-Env-B3 Contaminant Transport **NEW**

Major types of contaminants in air, surface water and ground water. Physical phenomena governing the transport of contaminants in different environments: advection, dispersion, diffusion, sorption, ion exchange, precipitation, dissolution, volatilization, equilibrium partitioning of contaminants amongst air, water, soil, sediments and biota. Development of governing transport equations, initial and boundary conditions, completely mixed and plug flow systems. Analytical and numerical solutions, model development, calibration, verification, sensitivity analysis, prediction and post audit.

Suggested Texts:

Fetter, C.W., Contaminant Hydrogeology. 2nd Ed., Prentice Hall, 1998.
Schnoor, J.L., Environmental Modeling: Fate of Chemicals in Water, Air and Soil. John Wiley & Sons, New York, 1996

Wark, K., C.F. Warner and W.T. Davis, Air Pollution: Its Origin and Control. Addison and Wesley, 1998.

Zheng, C. and G. D. Bennett, Applied Contaminant Transport Modeling, Theory and Practice. Van Nostrand Reinhold, New York, 1995.

04-Env-B4 Site Assessment and Remediation **WAS 98-ENV-B5**

Introduction to engineering, regulatory and management aspects of site assessments and restoration. Fundamentals and interactions between soils, groundwater, contaminants, and microorganisms. Site characterization and investigations. Monitoring and sampling strategies and techniques. Remedial action screening. Engineered solutions for site remediation including: physical, chemical, biological and in-situ and ex-

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situ techniques. Risk assessment. Brownfields. Computer modeling for assessment and remediation.

ADD

Suggested Texts:

Ewels, J., Bioremediation Principles. McGraw Hill, 1998. ISBN: 0070577323

Lerch, I. And Paleologos, E., Environmental Risk Analysis. McGraw Hill, 2001. ISBN: 0071372660

Spitz, K. and Moreno, J., A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience, 1996. ISBN: 0471136875

Cookson, J.T., Jr., Bioremediation Engineering - Design and Application. McGraw-Hill, New York, NY, 1995.

Ott, W., Environmental Statistics and Data Analysis. Lewis Publishers, 1994. ISBN: 0873718488

SPLIT FROM 98-ENV-B6

04-Env-B5 Industrial & Hazardous Waste Management

REWRITTEN

Definition and characteristics of industrial and hazardous wastes. Industrial and hazardous waste generation rates and prevention. Introduction to I&H waste collection, transportation, treatment, monitoring, and disposal. Applicable international, federal and provincial regulations and initiatives. Municipal services and planning associated with industrial and hazardous waste management. Physical, chemical and biochemical treatment technologies, and disposal methods, including landfilling and incineration. Environmental impact of industrial and hazardous waste management. Radioactive, nuclear and biomedical waste.

Suggested Texts:

Freeman, H.M., and Harris, E.F., Hazardous Waste Remediation – Innovative Treatment Technologies. Technomic Publishers Lancaster P.A., 1995.

Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience 1994. ISBN: 0-471-30681-9.

Sharma, H.D., and Lewis, S.P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.

Bellandi, R. (ed), Hazardous Waste Site Remediation: The Engineer's Perspective. Wiley Interscience, 1995. ISBN: 0471286931.

04-Env-B6 Agricultural Waste Management

WAS 98-ENV-B7

Agricultural sources of pollution (pesticides, commercial fertilizer, on-farm food processing wastes and animal manure) and their effect on the total environment. Physical, chemical and biological properties of agricultural waste materials. Design of storage and pumping systems for manure holding facilities. Physical, chemical and biological treatment processes of agricultural wastes in relation to pollution control and

waste utilization. Various methods of land application of agricultural wastes in relation to pollution problems and fertilizing value. Technologies for utilization of agricultural wastes for biogas production and animal feed. Air pollution and greenhouse gas emissions control. Water quality parameters and lake and river water quality management.

Suggested Text:

Unger, P.W., Managing Agricultural Residues. Lewis Pub., 1994. ISBN: 0-873-71730-9.

04-Env-B7 Environmental Sampling And Analysis **NEW**

Practical and essential principles of water, soil and air sampling. Basic concepts in quantitative analyses of physical, chemical, and biological parameters. Tolerable levels of contaminants in air, water and soil. Sampling, sample preparation and preservation techniques, and quality assurance and quality control. Development of optimum monitoring strategy, scheduling, and sampling frequency. Database management, data analysis, statistical treatment of data, sources of error, and seasonal effects. Instrumental methods of analysis for organic and inorganic contaminants in air, water, and soil: colorimetry, chromatography, spectroscopy, electrochemical probes, remote sensing and bioassays. Basic concepts of resolution, accuracy, precision, sensitivity, calibration and control of error. Laboratory certification and standardization.

Suggested Texts:

Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada. Canadian Council of Ministers of the Environment The National Contaminated Sites Remediation Program March 1996.

Shugar, G.L., S.L. Bauman, D.A. Drum and J. Lauber, Environmental Field Testing and Analysis Ready Reference Handbook.

Montgomery, D C, Design and Analysis of Experiments. (5th Ed.), Wiley, New York, 2000.

04-Env-B8 Instrumentation and Process Control

WAS 98-ENV-B9
EXTENSIVE EDITS

Basic concepts of resolution, accuracy, precision, sensitivity, calibration and control of error. Analysis and interpretation of data. Transducers for the sensing of strain, displacement, velocity, acceleration, pressure, flow, temperature, humidity, moisture content, and electromagnetic radiation. Signal conditioning for noise reduction and control. Operational amplifiers. Systems for data acquisition, telemetry, display, recording and processing. Computer interfacing. Concept of transfer functions. Response of simple chemical processes to step, ramp, and sinusoidal inputs. Transient response of interacting elements in series. Frequency response analysis of simple systems. On-off control, proportional, integral, derivative, and combinations of these control actions. Feed-back and feed-forward control. Controller tuning and algorithms. Simple stability analysis. Dynamics and control of common chemical process units.

Suggested Text:

Nachtigal, C.L., Instrumentation and Control - Fundamentals and Applications. John Wiley & Sons, Inc., NY, 1990.

04-Env-B9 Environmental Chemistry and Microbiology

**WAS 98-ENV-A2 & 98-ENV-B11
REWRITTEN**

Chemistry of organic and inorganic contaminants in the environment. Natural chemical cycles in the biosphere, geosphere, hydrosphere and atmosphere, and consequences of anthropogenic disturbances. Chemical equilibrium and kinetics. Fundamentals of aquatic, atmospheric and soil chemistry. The fate of hazardous, refractory and heavy metal pollutants in the environment. Introduction to microbial taxonomy, ecology and growth kinetics of microorganisms. The microbes of public health importance in water, soil and air, including their detection, occurrence, transport, and survival in the environment. Introduction to the application of different processes to remove contaminants in natural and engineered systems.

Suggested Texts:

McCarty, P., Parker G. and C. Sawyer, Chemistry for Environmental Engineering. McGraw Hill, 1994. ISBN: 0070549788

Connell, D.W., Basic Concepts of Environmental Chemistry. Lewis Publishers, 1997. ISBN: 0873719980

Evangelou, V.P. Environmental Soil and Water Chemistry: Principles and Application. Wiley Interscience, 1998. ISBN: 0471165158

Maier, R.M., Pepper, I. and Gerba, C. Environmental Microbiology. Academic Press, 2000. ISBN: 012497570-4

ENVIRONMENTAL ENGINEERING EXAMINATIONS SYLLABUS

GROUP A

COMPULSORY EXAMINATIONS (SEVEN REQUIRED)

98-Env-A1 Principles of Environmental Engineering

Population, economic growth, industrialization, urbanization and energy-use, as causes of environmental pollution. Mass and energy balance for reacting and non-reacting environmental engineering systems under steady state and unsteady state conditions. Fundamentals of momentum, heat and mass transfer. Physical and transport properties of homogeneous and heterogeneous mixtures. Thermodynamic and phase equilibria considerations. Contaminant partitioning and transport in air, surface water and groundwater. Characteristics of particles, chemistry of solutions and gases, material balances, reaction kinetics, microbiology and ecology, as related to the environment. Application of environmental principles (technical and non-technical to: water resource management, water and wastewater treatment, air pollution control, solid waste management, environmental impact assessment, and environmental ethics. Thermal pollution. Noise pollution. Introduction to greenhouse effect, sustainable development, life cycle analysis, and environmental quality objectives, standards and guidelines.

98-Env-A2 Environmental Chemistry

Chemistry of organic and inorganic contaminants in the environment. Natural chemical cycles in the biosphere, geosphere, hydrosphere and atmosphere, and consequences of anthropogenic disturbances. Aquatic, atmospheric and soil chemistry. The fate of hazardous, refractory and heavy metal pollutants in the environment. Introductory toxicological chemistry. Analytical techniques for contaminants in air, water and soil.

98-Env-A3 Hydrology and Hydraulics

Hydrologic systems and processes; precipitation and snow melt, runoff, infiltration, mass curves, and intensity, duration and frequency relationships, conceptual models of runoff, hydrographs, and simulation methods; frequency and probability with application to precipitation, floods and droughts; evaporation and evapotranspiration. The application of integral and differential techniques for solving problems involving mass, energy and/or momentum transport through solids and within fluids. Steady and unsteady state processes. Molecular transport. Effects of hydraulic structures on river surface profiles and sediment transport. Hydraulic principles: conveyance of water through open-channel and closed channel systems including flow under uniform and gradually varied conditions, control sections, hydraulic jumps, and energy dissipation; hydraulic transients, closed conduit flow in single pipes and in pipe networks; surges and water hammer in closed conduits. Dimensional analysis and hydraulic models. Elements of storm water management; and design flows.

98-Env-A4 Soil Mechanics and Groundwater

Origin of soils, soil identification and classification. Compaction. Permeability, pore water pressure and effective stress. Compressibility and consolidation. Particle size distribution, water retention in soils, water movement, radioisotope phenomena and utilization. Swelling and shrinking, soil structure and its measurements, soil temperature and freezing. Pore water pressure, seepage pressure, and groundwater considerations in soil engineering. Subsurface exploration methods, soil strength, settlement and consolidation, compaction, slope stability, infiltration. Geologic aspects of environmental concerns and material hazards. Design of structures and waste disposal sites. Fundamentals of groundwater hydrologic processes; groundwater movement, infiltration mechanics, fundamentals of flow of water through saturated and unsaturated porous media; hydraulic conductivity and groundwater storage; groundwater flow patterns; recharge discharge, flow net construction and analysis, movement of dissolved species; aquifer development and management.

98-Env-A5 Physical, Chemical and Biological Processes

Physical, chemical and biological process concepts as applied to gases, liquids and solids. Mass balances; flow models; reactors. Physical unit operations: screening, sedimentation, filtration; membranes, absorption and desorption; particulate separation; solids sorting. Chemical unit processes: precipitation; coagulation and flocculation, adsorption, disinfection, basic oxidation processes. Biological unit processes; effect of hydraulic design; kinetic models; activated sludge, attached growth systems. Modeling.

98-Env-A6 Environmental Assessment and Management Systems

Environmental regulations. Analysis of environmental impact using technical and non-technical parameters. Review of statistical inference. Application of statistical techniques to monitoring programs including sampling and statistical estimation theory, hypothesis testing, e regression analysis, analysis of variance, covariance analysis, joint distributions, nonparametric tests, probability plotting and testing of distributional assumptions. Risk analysis. Design of site investigations and monitoring schemes. Environmental impact assessment legislation. Environmental impact assessment applied to solid and liquid waste management, effluent control, air pollution control, urban development, and transportation systems. Legal and regulatory framework. Institutional, procedural and methodological issues. Introduction to geographical information systems (GIS). Environmental management systems (EMS) ISO 14000/14001 standards, and application.

98-Env-A7 Sustainable Systems and Preventative Engineering

Implications of finite biosphere and complexities inherent in environmental decision-making. Design of controlled environments to enhance health and productivity; protection of natural resources for sustainable production. Resource problems with ecological, economic, demographic and social dimensions. Techniques to integrate knowledge, define policy and facilitate communications. Life cycle analysis. Basic planning studies, including population, economic, and land-use studies. The strategy, development, and engineering associated with infrastructure development including housing, industry, transportation, and social service components. The use of analytical procedures and data systems. Plan implementation measures and controls.

GROUP B

ELECTIVE EXAMINATIONS (THREE REQUIRED)

98-Env-B1 Air Quality

Engineering aspects of air pollution. Sources and dispersion of atmospheric pollutants. Control methods for particulates, gases, and vapours. Photochemical reactions, noxious pollutants, and odour control. Measurement techniques. Characteristics of various air pollutants, their behaviour in the atmosphere, monitoring and modelling issues and problems, technology of particle collection and control of pollutant gases. Sources and dispersion of atmospheric pollutants. Control methods for particulates, gases, and vapours. Dispersion modelling. Acceptable risk level for noise, and effects of noise. Measurement of noise, and control approaches.

98-Env-B2 Water Resources Management

Nature of waste inputs to water systems, points source and non-point source loading rates. River flow, diffusion and dispersion regimes, pollutant transport mechanisms and modelling, lake and estuaries models. Microorganism survival models, dissolve oxygen models, eutrophication reduction, toxic substances and heat management. Application of computer-based models for water quality and contaminant transport, contaminant decay modeling. Global and national water problems, law and legislation. Water tariff structures. Hydraulic structure. Quantity estimation of water. Reservoir analysis. Water storage and distribution systems. Design elements of water distribution systems and system modelling. Technology and impacts of water conservation practices and policies on municipal service infrastructure. Measurement techniques. Urban drainage and runoff control; meteorologic data analysis, deterministic and stochastic modeling techniques. Flood control: structural and nonstructural alternatives. Effects of hydraulic structures on river surface profiles and sediment transport. Power generation: hydro and thermal power generation. Low flow augmentation. Economics and decision making.

98-Env-B3 Municipal Wastewater

Regulation of water quality for discharge; elements of receiving water characterization, and specification of effluent limits. Wastewater characterization and quantity estimation; flow and variability modelling; wastewater quality and variability; standards, regulations and guidelines; selecting design objectives. Wastewater collection and pumping systems. Fundamentals of physical, chemical and biological processes, principles of preliminary, primary, secondary and tertiary treatment processes. Elements of wastewater treatment; filtration, settling, disinfection, aeration, physical, chemical and biological processes. Design of aerobic systems (i.e. various types of activated sludge, moving bed biofilm reactors, rotating biological contactors, fluidized bed reactors, and trickling filters); design of anaerobic systems (i.e. various types of digestors, anaerobic filters); plant hydraulic design; clarifier design; filtration design. Microbial growth kinetics; gas transfer. Sludge management; sludge treatment (aerobic, anaerobic, thermophilic, etc.); design of land application systems; microorganism (pathogen) reduction systems. Chemical treatment; flocculation, coagulation, sedimentation, and filtration. Natural treatment systems including wetlands, lagoon systems, and overland flow. Effluent disposal (soil and water) and re-use. Effluent disinfection system selection and design. Instrumentation applications; monitoring and control. Stormwater management, control and treatment system design.

98-Env-B4 Industrial Wastewater Management

Industrial wastewater characterization, treatment objectives and regulations. Quantity estimation of wastewater. Waste minimization through process modifications. Wastewater flow and variability modeling. Equalization and flow regulation. Design of unit operations involving physical, chemical and biological processes. Solids separation including sedimentation, dissolved air flotation, and filtration. Solids management, treatment, and disposal. Process flow diagrams (PFD) for wastewater treatment facilities in selected industries, such as pulp & paper, food processing, chemical, metallurgical, mining, petroleum, etc. Process simulation. Instrumentation applications; monitoring and control. Preparation of process and instrumentation diagrams (PID). Economic considerations.

98-Env-B5 Site Assessment and Remediation

Introduction to regulatory, management and engineering aspects of site restoration. Fundamentals and interactions between soils, contaminants, and micro-organisms. Site characterization. Remedial action screening. Risk assessment. Feasibility studies. Restoration techniques: in situ (including natural attenuation and source isolation), and ex-situ. Thermal, physical, chemical, and biological processes as unit operations, coupled processes and complete restoration systems.

98-Env-B6 Solid and Hazardous Waste Management

Characteristics of solid and hazardous wastes; introduction to waste collection, treatment, disposal, and containment and landfill design. Evaluation of current practice and analysis of future potential of landfills, composting, combined treatment, recycle and re-use. Biosolids treatment, uses, and disposal. Municipal services and planning associated with solid and hazardous waste management. Waste recycling. Bio-hazard waste handling, treatment and disposal. Waste reduction, recycling, and reuse.

98-Env-B7 Agricultural Waste Management

Agricultural sources of pollution (pesticides, commercial fertilizer, on-farm food processing wastes and animal manure) and their effect on the total environment. Physical, chemical and biological treatment processes of agricultural wastes in relation to pollution control and waste utilization. The physical, chemical and biological properties of agricultural waste materials related to current handling and disposal methods. Solutions of practical problems on pumping aspects of liquid manure, lagoon design and manure holding facilities. Various methods of land application of agricultural wastes in relation to pollution problems and fertilizer values. Technological advances of utilization of agricultural wastes for biogas production and animal feed. Air pollution control. Water quality parameters and lake and river water quality management. Water and wastewater treatment systems. Solid waste management and soil erosion and sediment control.

98-Env-B8 Built Environment

Introductory principles of systems engineering and analysis, materials handling techniques and equipment. Heat and moisture production and environmental modification. Summer and winter ventilation systems. Controlled atmosphere, modified atmosphere, and ventilated storage systems. Sick building syndrome. Environmentally aware material choices. Environmental ergonomics. Noise within the working environment and noise control measures. Wave properties; the decibel; hearing, deafness, and hearing protectors; noise criteria and regulations; sound measurement; sound-source characterization; real noise sources, sound propagation outdoors, in ducts and pipes and in rooms; sound transmissions; silencers; sound absorbers; partitions. Factors affecting the functional requirements of buildings including principles of planning, and economics of design.

98-Env-B9 Instrumentation and Process Control

Basic concepts of error, resolution, accuracy, precision, sensitivity and calibration. Analysis and interpretation of data. Transducers for the sensing of strain, displacement, velocity, acceleration, pressure, flow, temperature, humidity, moisture content, and electromagnetic radiation. Signal conditioning for noise reduction and control. Operational amplifiers. Systems for data acquisition, telemetry, display, recording and processing. Computer interfacing. Concept of transfer functions. Response of simple chemical processes to step, ramp, and sinusoidal inputs. Transient response of interacting elements in series. Frequency response analysis of simple systems. On-off control, proportional, integral, derivative, and combinations of these control actions. Feed-back and feed-forward control. Controller tuning and algorithms. Simple stability analysis. Dynamics and control of common chemical process units such as heat exchangers, simple reactors, and agitated vessels.

98-Env-B10 Water Treatment

Comprehensive water treatment facility design including: environmental impacts; water sources; quantity and quality estimation; regulations; water storage and distribution systems; master planning; treatment process selection; ion exchange, membrane and activated carbon processes; aeration; coagulation & flocculation; precipitation, sequestration, sedimentation; slow sand filtration; mixed media filtration; membrane filtration; reverse osmosis; oxidation and disinfection alternatives; chemical feed systems; pilot plants; site selection; detailed design considerations; hydraulics; costing; instrumentation and control; operations and maintenance; construction methods, facility start-up and commissioning. Contaminated groundwater treatment. Application of computer based water quality and distribution modelling. Water treatment plant sludge management.

98-Env-B11 Environmental Microbiology

Basic microbiology and biochemistry of cells, biochemical kinetics, enzymes, metabolic pathways, transport phenomena and reactor design as applied to biochemical reactors. General principles involved in the study of microorganisms and their relation to human health. Epidemiology of disease and the measures to prevent the transmission of pathogenic organisms. Fundamental properties of prokaryotes: structure, metabolic diversity, environmental relationships, growth, genetics and applications. Analysis and identification of microorganisms and significance with respect to public health. The structure and properties of biological populations and communities and their application to the solution of engineering problems.

Recommended Textbooks for Professional Environmental Exams

98-Env-A1 – Principles of Environmental Engineering

Kiely, G. 1996. Environmental Engineering. McGraw Hill ISBN: 007091272

98-Env-A2 – Environmental Chemistry

McCarty, P., Parker G. and C. Sawyer. 1994. Chemistry for Environmental Engineering. McGraw Hill ISBN: 0070549788

Connell, D.W. 1997. Basic Concepts of Environmental Chemistry. Lewis Publishers ISBN: 0873719980

Evangelou, V.P. 1998. Environmental Soil and Water Chemistry: Principles and Application. Wiley Interscience ISBN: 0471165158

98-Env-A3 – Hydrology and Hydraulics

Wanielista, M., Kersten, R., and R. Eaglin. 1996. Hydrology: Water Quantity and Quality Control. Wiley Interscience ISBN: 0471072591

Zipparro, V.J. 1993. Davis' Handbook of Applied Hydraulics Fourth Edition. McGraw Hill ISBN: 0070730024

Franzini, J., Freyberg, D., Linsley, R., and G. Tchobanoglous. 1991. Water Resources Engineering. McGraw Hill ISBN: 0070380104

98-Env-A4 – Soil Mechanics and Groundwater

Cernica, J.N. 1995. Geotechnical Engineering: Soil Mechanics. Wiley Interscience. ISBN: 0471308846

Fredlund, D.G. and H. Rahardjo. 1993. Soil Mechanics for Unsaturated Soils. Wiley Interscience. ISBN: 047185008X

Spitz, K. and J. Moreno. 1996. A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience. ISBN: 0471136875

LaMoreaux, P.E., and LaMoreaux, J.W. 1997. Environmental Hydrogeology. Lewis Publishers. ISBN: 0873719492

98-Env-A5 – Physical, Chemical and Biological Processes

Casey, T.J. 1997. Unit Processes in Water and Wastewater Engineering. Wiley Interscience. ISBN: 0471966932

Weber, W.J. and DiGiano, F.A. Process Dynamics in Environmental Systems. Wiley Interscience. ISBN: 0471017116

McCarty, P., and Rittmann, B. 2000. Environmental Biotechnology: Principles and Applications. McGraw Hill. ISBN: 0072345535

98-Env-A6 – Environmental Assessment and Management Systems

- Canter, L. 1996. Environmental Impact Assessment. McGraw Hill. ISBN: 0070097674
- Bartell, S., Kolluru, R., Pitblado, R., and Stricoff, S. 1996. Risk Assessment and Management Handbook: For Environmental, Health and Safety Professionals. McGraw Hill. ISBN: 0070359873
- Lerch, I. And Paleologos, E. 2001. Environmental Risk Analysis. McGraw Hill. ISBN: 0071372660
- McGraw, D. 1993. Environmental Auditing and Compliance Manual. Wiley Interscience. ISBN: 0471285854
- Woodside, G. Yturri, J. and Aurriccho, P. 1998. ISO 14001 Implementation Manual. McGraw Hill. ISBN: 0070718520

98-Env-A7 – Sustainable Systems and Preventative Engineering

- Curran, M. 1996. Environmental Life-Cycle Assessment. McGraw Hill. ISBN: 007015063X
- Dorf, R.C. 2001. Technology, Humans and Society: Toward a Sustainable World. Academic Press. ISBN: 0122210905
- Pearce, D. and Barbier, E. 2000. Blueprint for a Sustainable Economy. Earthscan Publications. ISBN: 1853835153

98-Env-B1 - Air Quality

- Alley, E.R, Stevens, L.B., and Cleland, W. L., Air Quality Control Handbook. McGraw-Hill, 1998. ISBN: 0-07-001411-6.
- Buonicore, A.J. (ed) and W.T. Davis (ed), Air Pollution Engineering Manual. Air & Waste Management Association. Wiley-Interscience, 1992. ISBN: 0-471-28441-6.

98-Env-B2 - Water Quality

- Mays, L. 1996. Water Resources Handbook. McGraw Hill. ISBN: 0070411506
- Biswas, A. 1997. Water Resources: Environmental Planning, Management, and Development, McGraw Hill. ISBN 0070054835
- Ward, R.C., Loftis, J.C. and McBride, G.B. 1990. Design of Water Quality Monitoring Systems. Wiley Interscience. ISBN: 0471283886
- Veissman, W. and Hammer, M. 1998. Water Supply and Pollution Control (6th Ed.) Addison Wesley. ISBN: 032101460X

98-Env-B3 – Municipal Wastewater

Metcalf & Eddy, Inc. 1981. Wastewater Engineering: Collection and Pumping of Wastewater. McGraw-Hill. ISBN: 007041680X

Burton, F., Metcalf and Eddy Inc, Tchobanoglous, G. 1991. Wastewater Engineering: Treatment, Disposal and Reuse. McGraw Hill. ISBN: 0070416907

Reed, S.C. and Crites, R.W. 1996. Natural Systems for Waste Management and Treatment. McGraw Hill. ISBN: 0071346627

98-Env-B4 - Industrial Wastewater Treatment

Eckenfelder, W.W. (Jr). 1989. Industrial Water Pollution Control, (2nd Ed). McGraw-Hill, 1989. ISBN: 007018903X.

Guyer, H.H., 1998. Industrial Processes and Waste Stream Management. Wiley Interscience. ISBN: 0471299847.

Bishop, P. 2000. Pollution Prevention: Fundamentals and Practice. McGraw Hill. ISBN: 0073661473

98-Env-B5 - Site Assessment and Remediation

Ewels, J. 1998. Bioremediation Principles. McGraw Hill. ISBN: 0070577323

Lerch, I. And Paleologos, E. 2001. Environmental Risk Analysis. McGraw Hill. ISBN: 0071372660

Spitz, K. and Moreno, J. 1996. A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience. ISBN: 0471136875

Cookson, J.T., Jr. 1995. Bioremediation Engineering - Design and Application. McGraw-Hill, New York, NY.

Ott, W. 1994. Environmental Statistics and Data Analysis. Lewis Publishers. ISBN: 0873718488

98-Env-B6 - Solid and Hazardous Waste Management

Freeman, H.M., and Harris, E.F. 1995. Hazardous Waste Remediation – Innovative Treatment Technologies. Technomic Publishers Lancaster P.A.

Bagchi, A. 1994. Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience. ISBN: 0-471-30681-9.

Sharma, H.D., and Lewis, S.P. 1994. Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience. ISBN: 0471575364.

Bellandi, R. (ed). 1995. Hazardous Waste Site Remediation: The Engineer's Perspective. Wiley Interscience. ISBN: 0471286931.

98-Env-B7 - Agricultural Waste Management

Raymond C. Loehr, 1984, Pollution Control for Agriculture, 2nd edition, Academic Press.

Metcalf & Eddy, Inc. (1991). Wastewater Engineering: Treatment, Disposal, and Reuse, 3rd edition, McGraw Hill, Inc., New York, NY 1334

98-Env-B8 - Built Environment

Moore, F., Environmental Control Systems: Heating, Cooling, Lighting. McGraw-Hill, 1993. ISBN: 0-07-042889-1.

Nims, D., Basics of Industrial Hygiene. Wiley Interscience, 1999. ISBN: 0-471-29983-9.

98-Env-B9 - Instrumentation and Process Control

Nachtigal, C.L., Instrumentation and Control - Fundamentals and Applications. John Wiley & Sons, Inc., NY., 1990.

98-Env-B10 - Water Treatment

American Water Works Association. 1997. Water Treatment Plant Design, (3rd Ed.). McGraw-Hill. ISBN: 0070016437.

American Water Works Association. 1998. Water Quality and Treatment: A Handbook of Community Water Supplies. McGraw Hill. ISBN: 0070015406

Kawamura, S. 2000. Integrated Design and Operation of Water Treatment Facilities. Wiley and Sons. ISBN: 0471350931

Nyer, E.K. 1992. Groundwater Treatment Technology, (2nd Ed.). Wiley Interscience. ISBN: 0471284149.

98-Env-B11 – Environmental Microbiology

Maier, R.M., Pepper, I. and Gerba, C. 2000. Environmental Microbiology. Academic Press. ISBN: 012497570-4