TOTAL EXAMINATION PROGRAM

PEO Syllabus of Examinations, 2007 Edition

WATER RESOURCES ENGINEERING

REDLINES FOR CHANGES ONLY

PROFESSIONAL EXAMS – SPECIFIC TO WATER RESOURCES ENGINEERING

GROUP A

07-WRSE- A1 Water Quality & Management

Standard methods of water quality analysis for physical, chemical and biological characteristics of water; significance and interpretation of analytical results; modelling of water quality in natural systems; and introduction to engineered water and wastewater treatment systems; management of water supply, irrigation, flood control, drainage and water pollution control; economic and social aspects of water management decisions.

07-WRSE- A2 Engineering Hydrology (16-Civ-B4)

Hydrologic processes: precipitation and snow melt, infiltration, evaporation and evapotranspiration, ground-water flow, runoff. Point and area estimates of precipitation. Stream flow measurement. Runoff hydrographs, unit hydrographs, conceptual models of runoff, and basics of hydrologic modelling. Channel system: reservoir and lake routing, channel routing and flood wave behavior Statistical methods: frequency and probability with application to precipitation, floods, and droughts.

Urban and highway drainage structure design.

07-WRSE- A3 Soil Mechanics & Groundwater

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.

07-WRSE- A4 Hydraulics Engineering (16-Civ-A5)

Dimensional analysis and hydraulic models. Application of continuity, momentum and energy principles. Steady, closed conduit flow in single pipes and pipe networks. Steady, open-channel flow under uniform and gradually varied conditions, control sections, hydraulic jumps, and energy

dissipaters. Hydraulic transients; surges and water hammer in closed conduits, surface waves in open channels. Concepts and principles of turbo machinery, especially centrifugal pumps; similarity relations and cavitation; operation of pump-and-pipe systems.

Introductory concepts of hydraulic structures, including environmental aspects of hydraulic works and water quality management.

Hydraulic aspects of the theory and design of hydraulic structures. Storage dams, spillways, outlet works, diversion works, drop structures, stone structures, conveyance and control structures, flow measurement and culverts.

07-WRSE- A5 Water Resources Planning & Systems

Application of engineering economics, microeconomic theory, and mathematical simulation and optimization models to the planning and management of water systems; major topics include systems analysis, flood control, hydroelectric power, water supply, multi-objective planning, and urban water resource management.

07-WRSE- A6 Municipal and Environmental Engineering (16-Civ-A3)

Municipal infrastructure including, water supply, wastewater disposal, roads and land development; population forecasting; demand analysis. Water supply; source development, transmission, storage, pumping, distribution networks. Sewerage and drainage; sewer and culvert hydraulics; collection networks; stormwater management. Maintenance and rehabilitation of water and wastewater systems; buried pipe design; optimization of network design.

Select ONE from:

07-WRSE- A7-1 Irrigation, Drainage & Erosion Control: (04-Agri-B6) (22-AGRIC-B6)

Irrigation: Land classification, development, and preparation. Consumptive use of water, estimation of crop water requirements. Design of distribution systems, canals and structures, design of sprinkler and surface systems. Selection of nozzles, pipes, pump, and power units. Analysis of rate of advance and recession curves. Irrigation efficiencies. Design of low earth dams.

Drainage: Design, layout and installation of subsurface and surface systems. Spacing formulae for steady-state and transient conditions. Outlet ditch design. Flow through bridges and culverts. Drainage pumps, secondary drainage practices, surface drainage, grading, land levelling, water table control. Use of drainage systems to control water pollution. Implications of draining wetlands.

Erosion Control: Basic principles of wind and water erosion. Soil loss prediction methods and sustainability. Methods of soil erosion and sediment control including contouring, terracing, grass waterways, silt fences, channel stabilization, and land management practices. Agroforestry and cropping systems.

07-WRSE- A7-2 Geomatics: (07-Tra-B10)

Satellite-based positioning systems (GPS); observations and development of mathematical models used for absolute and differential static and kinematic positioning; error analysis; quantitative remote sensing methods using optical, infrared and microwave radiation; physical principles, including governing equations; imaging system geometries; space and airborne sensor systems; radiometric corrections, including calibration and atmospheric correction; geometric corrections; geographic

Information Systems (GIS); characteristics of GIS data structures and database management systems; applications to map projections; geodetic datums; coordinate systems; georeferencing; spatial modelling and analysis.

GROUP B

07-WRSE- B1 Geomorphology & Pleistocene Geology: (18-Geol-B4)

Basic geomorphological concepts: formation and composition of landforms, geomorphologic cycles. Weathering and soils. Mass wasting. Fluvial processes and landforms. Coastal processes and landforms. Glacial geomorphology and landforms. Frozen-ground phenomena. Karst geomorphology. Physical geology of Canada. Quaternary geology of selected areas of Canada. Influence of geomorphology on human activity.

07-WRSE- B2 Numerical Methods

Introduction to numerical techniques for water resources systems, focusing on the understanding of fundamental principles and an appreciation of the role of models. Finite difference, finite element, and particle tracing methods are studied and applied to the solution of problems.

07-WRSE- B3 Water Supply and Waste Water Treatment: (16-Civ- B5)

Physical, chemical, and microbiological characteristics of water and wastewater. Regulation of water quality for supply and discharge, elements of receiving water characterization and specification of effluent limits. Elements of water and wastewater treatment including, coagulation, flocculation, filtration, settling, softening, disinfection, fluoridation, taste and odour control and biological processes. Sludge disposal.

07-WRSE- B4 Open Channel Hydraulics:

Analysis and characteristics of flow in open channels (natural and artificial); channel design considerations including uniform flow (rivers, sewers), flow measuring devices (weirs, flumes), gradually varied flow (backwater and other flow profiles, flood routing), rapidly varied flow (hydraulic jump, spillways), and channel design problems (geometric considerations, scour, channel stabilization, sediment transport).

07-WRSE- B5 Limnology:

Physical processes that affect the behaviour of lakes, including reservoirs, water filled mine pits, mine tailings, pond and other standing water bodies. Impacts of these processes on water quality and methods used in the rehabilitation of lakes.

07-WRSE- B6 Contaminant Transport: (18-ENV-B3)

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.

07-WRSE- B7 Coastal Engineering

This course covers basic wave theory, wave measurement, wave statistics, wave record analysis, wave transformation, tides, water levels and storm surges. It introduces design of breakwaters and ocean structures, and uses hydraulic and numerical coastal models. The final projects consist of the design of a breakwater, design of a hydraulic model of the breakwater and testing with the hydraulic model to determine breakwater stability. Environmental considerations, coastal zone management, coastal sediment transport and design in the coastal zone are also treated

07-WRSE- B8 River Engineering

Prediction and consequences of sediment transport, aggradation and erosion, meandering and braiding, design of river engineering structures, water quality modelling, hydraulic modelling of fluvial processes and control structures, numerical modelling of dispersion and environmental impact of river engineering projects

07-WRSE- B9 Modelling of Surface Water Quality

Development and application of water quality models for lakes, rivers, estuaries, and reservoirs. Derivation of differential equations of pollutant transport; kinetic relationships for physical and chemical transformation of substances; numerical and analytical solutions to transport equations; and calibration and verification of models.

07-WRSE- B10 Risk Management in Water Resources

Risk Terminology and quantified risk analysis (QRA) techniques, Safety analysis studies. Decision-making methods in environmental engineering including matrix methods, linear programming, network models, Lagrange multipliers and dynamic programming. The concept of risk, risk probability, dose response models, decision analysis and risk-cost-benefit analysis. Evaluating environmental systems: probability and predicting failure.

07-WRSE- B11 Principles of Environmental Engineering (18-ENV-A1)

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.

07-WRSE- B12 Environmental Assessment and Management Systems (18-ENV-B1)

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.

07-WRSE-A1, Water Quality & Management

George Tchobanoglous and E.D. Schroeder, Water Quality, Addison Wesley, 0-201-05433-7.

07-WRSE-A2, Engineering Hydrology

Viessman, Knapp, Lewis & Harbaugh, Introduction to Hydrology, 2nd Edition, Harper Row (ISBN # 0-7002-24971)

Ven Te Chow, David R. Maidment & Larry W. Mays, Applied Hydrology, McGraw-Hill, 1988, ISBN # 0-07-010810-2

Ray K. Linsley & Joseph B. Franzini, Water Resources Engineering, 3rd Edition, McGraw-Hill, 1979, ISBN # 0-07-037965-3

07-WRSE-A3, Soil Mechanics and Groundwater

Das, Braja M., Principles of Geotechnical Engineering, 5th edition; ISBN 0-534-38742-X

07-WRSE-A4, Hydraulics & Hydraulics Structures

R.L. Daughtery, J.B. Franzini and E.J. Finnermore, Fluid Mechanics with Engineering Applications, 8th Edition, McGraw-Hill, 1985 (omit chapters 5, 9, 16, and 17)

A suitable alternate text is:

V.L. Streeter, E.B. Wylie, Fluid Mechanics, SI Edition, McGraw-Hill, 1981 (omit chapter 6 on compressible flow) Note there may be a more recent version of this text if there is please use the latest edition.

07-WRSE-A5, Water Resources Planning & Systems

Water-Resources Engineering, 3rd edition, by David A. Chin; ISBN-13: 9780132833219

Civil and Environmental Systems Engineering, 2nd edition, by Charles S. Revelle, E. Earle Whitlatch, and Jeff R. Wright; ISBN-13: 9780130478221

The first text covers the water resources aspect (including economic considerations) of your course description, while the second text provides the systems analysis/multi-objective planning components of the course description.

07-WRSE-A6, Municipal Engineering

Viessman and Hammar, Water Supply and Pollution Control, 6th Edition, Harper Collins College Publishers ISBN # 0-321-01460-X, 1988

Brière, François G. (1999) Drinking-Water Distribution, Sewage, and Rainfall Collection, Presses internationale Polytechnique, École Polytechnique de Montréal. ISBN number: 2-55300-796-5

McGhee, T.J., Water Supply and Sewerage, 6th Edition, McGraw-Hill Publishing Co. ISBN # 0-07-060938-1, 1991

Metcalf & Eddy Inc., Wastewater Engineering: Collection and Pumping of Wastewater, McGraw-Hill Publishing Co. ISBN # 0-07-041680-X, 1981

07-WRSE-A7-1, Irrigation, Drainage, and Erosion Control

Schwab, G.O., D.D. Fangmeier, W.J. Elliot, and R.C. Fravert, Soil and Water Conservation Engineering. 4th Edition. J. Wiley & Sons, 1993.

Smedema & Rycroft, Land Drainage. Cornell U. Press, 1993.

James, L.G., Principles of Farm Irrigation System Design. Krieger Publishing Company, 1993.

07-WRSE-A7-2, Geomatics

Bossler J.D. (Editor), J.R. Jensen, R.B. McMaster, C. Rizos (Associate Editors) (2002). Manual of geospatial science and technology,
Taylor & Francis, ISBN: 0748409246.

1- For the GPS part:
Hofmann-Wellenhof B., H. Lichtenegger, J. Collins (2001). GPS: theory and practice, 5th revised edition, Springer-Verlag, ISBN: 3211828397.

2- For the Remote Sensing part:
Jensen J.R. (2007). Remote sensing of the environment: an earth resource perspective, 2nd Edition, Pearson Prentice Hall, ISBN-10: 0131889508; ISBN-13: 978-0131889507

3- For the GIS part:
Bernhardsen T. (2002). Geographic Information Systems: an introduction, 3rd edition, John Wiley & Sons, New York, ISBN: 0471419680.

07-WRSE-B1, Geomorphology & Pleistocene Geology

Prime Text:

Ingham, A.E. Hydrography for the Surveyor and Engineer. 3rd edition. Wiley, 1994. ISBN 0632029439.

Supplementary Texts:

Bowditch, N., American Practical Navigator, Volumes I and II. Topographic Centre, United States Defence Mapping Agency, 1976. ISBN 0403089948.

de Jong, C.D., G. Lachapelle, S. Skone, and I. Elema, Hydrography. Delft University Press, 2002.

Appleyard, S.F. et al., Marine Electronic Navigation, 2nd edition. Routledge & Kegan Paul, 1988.

Forrester, W. D., Canadian Tidal Manual. Department of Fisheries and Oceans, Canadian Hydrographic Service, 1983. ISBN 0660113414.

07-WRSE-B3, Water Supply and Wastewater Treatment
Viessman and Hammar, Water Supply and Pollution Control, 6th Edition, Harper Collins College Publishers ISBN # 0-321-01460-X, 1988

R.L. Droste, Theory and Practice of Water and Wastewater Treatment, J. Wiley and Sons Inc. New York, N.Y., 1997

07-WRSE-B4, Open Channel Hydraulics

Chow, Ven Te (1959) Open-Channel Hydraulics. New York, McGraw-Hill, 1959. ISBN 00701077693

07-WRSE-B5, Limnology

- Wetzel, Robert G.,
  - Limnology, W. W. Saunders Company, 1975, ISBN 0-7216-9240-0.
  - Limnology, Saunders, 1983, ISBN - 10:0030579139; ISBN - 13:9780030579134
  - Limnology: Lake and River Ecosystems, 3rd Edition, Academic Press, ISBN - 10:0127447601; ISBN - 13:9780127447605
  - Please consider only chapters in either of these editions concerning:
    - Heat and Energy (Chapter 6 in 1st edition), and
    - Hydrodynamics (Chapter 7 in 1st Edition).
- Castendyk, D.N. and Eary, L.E., 2009. Mine Pit Lakes, characteristics, Predictive Modeling, and Sustainability; Management Technologies for Metal Mining Influenced Water, Volume 3; Society for Mining, Metallurgy and Exploration. "Mine Pit Lakes" for title page.
  - Please consider only the following chapters:
    - 4, Hydrologic Characteristics and Classifications of Pit Lakes

    - 5, Stratification and Circulation of Pit Lakes
    - 17, Flooding Pit Lakes with surface Water
    - 21, Induced Meromixis.
- Jorgensen, S.E., 1980. Lake Management, Pergamon Press. ISBN0-08-022432-6.
    - Please consider only Chapter 4 in this book. "Lake Management" for title page and a copy of Chapter 4.

07-WRSE-B6, Contaminant Transport

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.

07-WRSE-B11, Principles of Environmental Engineering

David A. Cornwell, Mackenzie L. Davis, Introduction to Environmental Engineering,
McGraw-Hill Companies, October 2006 ISBN-13: 9780072424119, Edition Number: 4

Mackenzie Davis and Susan Masten, Principles of Environmental Engineering and Science, Product Dimensions, ISBN-13: 978-0073122359 ISBN-10: 0073122351, Publisher: McGraw-Hill

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

07-WRSE-B12, Environmental Assessment and Management Systems

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

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