Douglas College

EFFECTIVE: JANUARY 2006
CURRICULUM GUIDELINES

A.	Division:	**Academic**	Effective Date:	**January 2006**		
B.	Department / Program Area:	**Science and Technology**	Revision	**X**	New Course	
			If Revision, Section(s) Revised:	**H,M,N,O,Q**		
			Date of Previous Revision:	**June 07, 2000**		
			Date of Current Revision:	**October 21, 2004**		

C: CHEM 2303 **D: Environmental Chemistry** **E: 5**

Subject & Course No.	Descriptive Title	Semester Credits

F: Calendar Description:

This course begins with a brief introduction and overview of chemistry in the environment then covers a selection of the following topics: the chemistry of the stratosphere and troposphere and related environmental issues; the chemical and energetic basis for global warming and its impact on the environment; the chemical composition and behaviour of natural waters and the impact of acidic deposition; the quality, contaminants and purification of drinking water; the sources, chemistry and treatment of wastewater; a brief organic chemistry review followed by an examination of toxic organic chemicals in the environment; the chemistry and impact of heavy metals in the environment.

G: Allocation of Contact Hours to Type of Instruction / Learning Settings

Primary Methods of Instructional Delivery and/or Learning Settings:

Lecture/Laboratory

Number of Contact Hours: (per week / semester for each descriptor)

Lecture: 4 hours/week
Laboratory: 3 hours/week

Number of Weeks per Semester:

15 weeks

H: Course Prerequisites:

Chemistry 1110 (C or better)

I: Course Corequisites:

None

J: Course for which this Course is a Prerequisite
None

K: Maximum Class Size:

36

L: PLEASE INDICATE**:**

	Non-Credit			
	College Credit Non-Transfer			
X	College Credit Transfer:	Requested	Granted	**X**

SEE BC TRANSFER GUIDE FOR TRANSFER DETAILS (www.bccat.bc.ca)

M:

Course Objectives/Learning Outcomes

Upon completion of this course, the student will be able to:

1. Describe the structure of the Earth's atmosphere and name its various regions.

2. Describe the general chemical composition and the trends in temperature of the various regions of the atmosphere.

3. Outline the composition and chemistry of the stratospheric ozone layer.

4. Outline the various non-catalytic and catalytic mechanisms for ozone destruction in the stratosphere.

5. Describe the physical chemistry that leads to "holes" in the stratospheric ozone layer.

6. Discuss the role of CFCs in ozone destruction and current issues/potential solutions surrounding this topic.

7. State the common units used to describe the concentration of atmospheric components and convert gas concentrations between these units.

8. Use appropriate terminology to qualitatively describe the origin, occurrence and environmental effects of photochemical smog and some common techniques to reduce ground-level photochemical smog.

9. With the aid of appropriate chemical equations, qualitatively describe the origin, occurrence and environmental effects of acid deposition.

10. Qualitatively describe the origin, occurrence and environmental effects of ground-level, atmospheric particulate matter.

11. Use appropriate chemical equations and principles to describe the free radical chemistry which naturally takes place in the troposphere.

12. Use appropriate chemical equations and principles to describe the specific tropospheric chemistry associated with photochemical smog.

13. Use appropriate chemical equations and principles to describe the specific tropospheric chemistry associated with acidic deposition.

14. Qualitatively describe the various technologies currently being used or developed as solutions to ground-level air pollution.

15. Qualitatively describe the origin, occurrence and environmental effects of the major pollutants associated with indoor air pollution.

16. Qualitatively explain how the components of sunlight effect the rotation and vibration of molecules and how this leads to the "natural" greenhouse effect.

17. Give general discussion of evidence supporting the operation of an "enhanced" greenhouse effect.

18. Describe the mechanism(s) by which the major greenhouse gases (CO_2 and H_2O) are believed to contribute to the "enhanced" greenhouse effect.

19. Describe the mechanism(s) by which the minor greenhouse gases are believed to contribute to the "enhanced" greenhouse effect.

20. Give a general discussion of the evidence for and the various predictions about global warming.

21. State the major individual chemical species and groups of chemical compounds which are typically found in the natural waters of Canada and indicate the major sources of these.

22. Discuss the process of aerobic decomposition of organic matter in natural waters.

23. Discuss the process of anaerobic decomposition of organic matter in natural waters.

24. Describe the theory which underlies the measurement of biological oxygen demand (BOD) and chemical oxygen demand (COD) and qualitatively describe how these measurements are made.

25. Discuss the acid-base chemistry of natural waters due to the CO_2/carbonate system and include appropriate chemical equilibrium equations.

26. Discuss the impact of various sources of acidic disposition on the acid-base chemistry of natural waters and various strategies for mitigating this impact.

27. Qualitatively describe the process of acid mine drainage (use appropriate chemical equations) and discuss its impact on natural waters.

28. State the major chemical/biological constituents in Canadian drinking water whose maximum concentrations are controlled.

29. Describe the major source(s) of the drinking water contaminants described above.

30. Describe the various strategies used for purification of Canadian drinking water; include the chemicals involved and the contaminants which they treat.

31. Discuss the environmental impact of these purification processes.

32. Identify the major sources of wastewater in the industrialized world and name the major pollutants in each.

33. Sketch a block diagram of a municipal sewage treatment plant and briefly describe the purification/separation process that occurs in each step.

34. Sketch a block diagram of a tertiary effluent treatment plant for a pulp and paper mill and describe the purification/separation process which occurs in each step.

35. Define the terms pesticide, insecticide and herbicide.

36. Draw the chemical structures and the corresponding names of some common organochlorine insecticides (and related compounds) such as DDT, DDE, HCB, chlorinated cyclopentadienes, etc.

37. Draw the chemical structures and the corresponding names of some other common insecticides (e.g. organophosphates, carbamates, etc).

38. Discuss the concepts of bioconcentration, biomagnification and persistence as related to the environmental impact of insecticides.

39. Draw the chemical structures and the corresponding names of some common herbicides (e.g. triazines, metolachlor, phenoxy derivatives, etc).

40. Draw the parent structure of the polychlorodibenzo-p-dioxin group of compounds (i.e. “dioxins”).

41. Use chemical equations to illustrate how dioxins are formed during the syntheses of phenoxy herbicides and wood preservatives such as PCP.

42. Discuss other sources of dioxins in the environment.

43. Draw the parent structure of polychlorinated biphenyls (PCBs) and discuss their chemical properties and uses.

44. Draw the parent structure of the polychlorinated dibenzofuran group of compounds (i.e. "difurans") and describe how these compounds are produced during the synthesis of PCBs.

45. Give a general discussion of the toxicology and human health effects of PCBs, dioxins and difurans and the strategies for disposal of these chemicals.

46. Describe the common characteristics of polynuclear aromatic hydrocarbons (PAHs); draw the structures/names for the simple PAHs (e.g. naphthalene, anthracene, phenanthrene).

47. Discuss the formation, sources, properties and human health effects of PAHs.

48. Give the definition and general properties of "heavy metals" in the environment.

49. Discuss the toxicity/bioaccumulation of four common heavy metals: Hg, Pb, Cd, As.

50. For each of the heavy metals listed above, discuss the specific environmental chemistry, common sources and relevant Canadian case studies.

51. Describe the general chemical characteristics of soils and outline the mechanism(s) by which the four heavy metals above find their way into soils, sewage and sediments.

52. Outline the general methods for analysis of heavy metals in solid samples and discuss some methods for decontaminating these samples.

N:

Course Content

1. Introduction: Our Environment and its Chemistry.

2. Stratospheric Chemistry: The Ozone Layer
   Atmospheric structure and composition, the composition and chemistry of the stratospheric ozone layer, processes for ozone destruction, the ozone holes, role of CFCs in ozone destruction, current issues and potential solutions.

3. Tropospheric Chemistry: Ground-Level Air Pollution
   Concentration units for gas phase composition, introduction to important types of tropospheric air (photochemical smog, acidic deposition, particulates) and their consequences, basic tropospheric chemistry, the detailed chemistry of photochemical smog and acidic deposition, potential solutions to ground-level air pollution, special considerations for indoor air pollution.

4. Global Warming: The Greenhouse Effect
   Review of electromagnetic radiation and the composition of sunlight, molecular vibration/rotation and the natural greenhouse effect, evidence for an enhanced greenhouse effect, the major greenhouse gases (CO_2 and H_2O) and their impact, the minor greenhouse gases and their impact, evidence for and predictions about global warming.

5. Natural Waters: Chemistry and Impact of Pollutants
   The composition of natural waters: dissolved gases and solids, dissolved organic matter, suspended solids; aerobic and anaerobic decomposition of organic matter; BOD, COD; acidity/alkalinity, acidic deposition: sources and impact on natural waters, acid mine drainage: source and impact.

6. Drinking Water: Quality, Contaminants and Purification
   Specifications for drinking water, typical contaminants in drinking water, various strategies for purification of drinking water: chemistry and environmental impact.

7. Wastewater: Sources, Chemistry and Treatment
   Important sources and associated contaminants of wastewater, various strategies for treatment of wastewater: chemistry and environmental impact, sludges: composition and treatment.

8. Organic Chemistry Review
   A brief review of organic chemistry with emphasis on organic compounds with significant environmental impact.

9. Toxic Organic Chemicals in the Environment
Pesticides and insecticides, organochlorine insecticides: chemistry and environmental impact, other important insecticides, herbicides and wood preservatives: chemistry and the dioxin/difuran, problem, polychlorinated biphenyls (PCBs): chemistry and environmental impact, toxicology of PCBs and dioxins/difurans, polynuclear aromatic hydrocarbons: chemistry and environmental impact, toxic organic waste disposal: issues and case studies.

10. Heavy Metals in the Environment
Heavy metals: definition, toxicity and bioaccumulation, four heavy metals with significant environmental impact (Hg, Pb, Cd, As): chemistry and environmental impact, heavy metals in soils, sewage and sediments.

Laboratory Content
A selection of labs from the following list will be performed during the laboratory period:

1. Analysis of phosphate in water.
2. Effects of Heavy Metal Ions on Growth of Microorganisms
3. Determination of Nitrate in Water
4. Acidity and Alkalinity in Drinking Water
5. Sampling of NO_x ($NO+NO_2$) and particulates in Air
6. Salts (Ionic Compounds) in Water – Gravimetric Analysis
7. Measurement of Dissolved O_2, BOD and Rate of O_2 Absorption
8. Preparation and Properties of Ozone
9. Detection of Fuel Components by Gas Chromatography
10. Copper and Arsenic in Treated Wood
11. Ion Selective Electrodes
12. Partition Coefficient Determination
13. Colorimetric Analysis of Fluoride
14. Kjeldahl and Organic Nitrogen Analysis
15. Chlorine: Determination of Forms of Aqueous Chlorine
16. Calcium Carbonate Equilibria
17. Adsorption on Activated Carbon
18. Laboratory Experiment in Support of Term Project
19. Field Trips
20. Environmental Modelling

O: Methods of Instruction

A multi-faceted approach will be used to teach the course: a combination of lectures, class discussion, practical problem solving sessions, audio-visual material, student presentations and other educational tools will be used. Problem and research assignments will be regularly assigned, submitted and evaluated. The laboratory component of this course will stress analytical methods and their application to various aspects of environmental chemistry. Whenever possible, the material from the lecture and laboratory components of the course will be closely coordinated.

P: Textbooks and Materials to be Purchased by Students

Baird, Colin, Environmental Chemistry, W.H. Freeman, New York, 2nd Ed. 1999.

Q: Means of Assessment

The student's performance in the course will be based on the following evaluations:

1. Lecture Component (maximum 70%)
a) Two or three classroom tests will be given during the semester (about 30%)
b) A final exam covering the entire semester's work will be given during the final examination period (30%)
c) Problem and research assignments will be graded and class participation, particularly during semester discussions and student presentations, will be assessed (about 10%)
2. Laboratory (minimum 20%)
a) Written reports for each experiment will be graded. Reports will be either complete notebook reports or shorter report sheets. In addition, some written quizzes based on the lab material will be evaluated (17%)
b) Quantitative results of experiments performed on unknown samples will be graded (3%)

3. Term Project and Field Trips (about 10%)
In consultation with the instructor, each student will choose a term project involving a chemistry related environmental issue. The project will involve literature research, collection and analysis of appropriate samples and preparation (and presentation) of a term paper. Guidelines and requirements for the term project will be distributed by the instructor.

R: Prior Learning Assessment and Recognition: specify whether course is open for PLAR

No

Course Designer(s)

Education Council / Curriculum Committee Representative

Dean / Director

Registrar