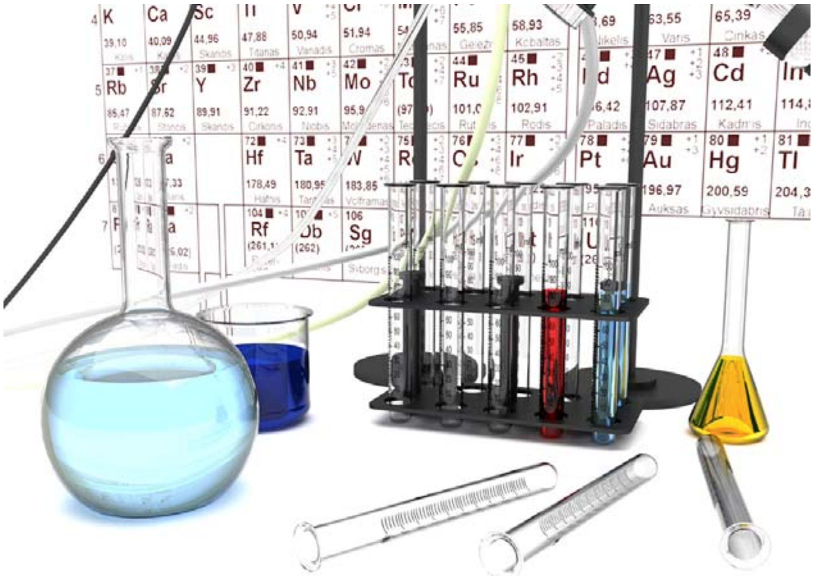
TRENT UNIVERSITY

Department of Chemistry

HONOURS DEGREE PROGRAMS



Information Booklet

2011-2012

Trent University
Department of Chemistry

Honours Degree Programs

Biochemistry & Molecular Biology

The chemistry of life processes touches at the heart of all things living. The Biochemistry & Molecular Biology program is designed to provide a foundation in the chemistry of biological systems, combining study of analytical, organic and physical chemistry with biochemistry, molecular biology and cell physiology. Students completing the program will have a detailed understanding of the processes that control and mediate health, illness, reproduction, growth, and ultimately life itself. Honours research projects introduce students to modern methods in protein chemistry, bioengineering and molecular biology.

Chemical Physics

The Chemical Physics program is designed for students who are interested in the study of the physics and physical chemistry of molecular and atomic-scale systems, and condensed matter. Course emphasis is on the physics and physical chemistry of atomic, molecular, and bulk systems, as well as the mathematical techniques and approaches needed to do quantitative work in these areas. A chemical physics education at Trent involves working closely with faculty and staff in formal lecture and informal laboratory and tutorial/workshop settings. Honours-year research projects offer an opportunity for students to obtain first-hand experience in modern chemical physics research design and methods.

Chemistry

Chemistry is the central discipline of science, with interdisciplinary links to all other physical science and many life science disciplines. The Chemistry Department offers a comprehensive range of courses in the fundamentals of analytical, biochemical, environmental, inorganic, organic and physical chemistry. Upper-level courses include study in advanced fundamentals, as well as computational, bioinorganic, and materials chemistry. Chemistry education at Trent involves working closely with faculty and staff in formal lecture and informal laboratory and tutorial/workshop settings. Many students choose to do an Honours year research project in which they obtain first-hand experience in modern chemical research design and methods.

Environmental Chemistry

Solving many environmental problems requires a solid background in both chemistry and environmental science. This program has been designed to provide a thorough grounding in fundamental chemical principles as well as a detailed understanding of environmental issues and their scientific context. Graduates of the Program will have experience with advanced instrumentation and modern analytical techniques, and will be prepared to handle challenging environmental problems from a multidisciplinary perspective.

Personnel

Faculty

The faculty of the Department bring with them experience in teaching and in research in a number of Canadian universities, as well as other universities in Great Britain, the United States, Australia, France, Germany and Russia.

P. Dillon, B.Sc., M.Sc., Ph.D., (Toronto), F.R.S.C., Professor, Environmental & Resource Studies Program and Department of Chemistry. Biogeochemistry; elemental cycling in aquatic ecosystems and their catchments; effects of regional and global-scale stressors including acid deposition, climate change, mercury and other trace metals on environmental chemistry; chemical processes in lakes.

Oni, S. K., M. N. Futter and P. J. Dillon. 2011. Landscape-scale control of carbon budget of Lake Simcoe: A process-based modelling approach. J. Gt. Lakes Res. 37: 160-165.

Kothawala, D. N., S. A. Watmough, M. N. Futter, L. Zhang and P. J. Dillon. 2011. Stream nitrate responds rapidly to decreasing nitrate deposition. Ecosystems. 14: 274-286.

Baulch, H. M., J. J. Venkiteswaran, P. J. Dillon and R. Maranger. 2010. Revisiting the application of open-channel estimates of denitrification. Limnol. Oceanogr.: Methods. 8: 202-215.

Landre, A., S. A. Watmough and P. J. Dillon. 2010. Metal pools, fluxes and budgets in an acidified forested catchment on the Precambrian Shield, central Ontario, Canada. Water Air Soil Pollut. 209: 209-228.

Koprivnjak, J.-F., P. J. Dillon and L. A. Molot. 2010. Importance of CO2 evasion from small Boreal streams. Glob. Biogeochem. Cycles. 24: GB4003, doi:10.1029/2009GB003723

D.A. Ellis. B.Sc. (Glasgow), M.Sc. (Analytical, Aberdeen), M.Sc. (Synthetic Organic, Toronto), Ph.D. (Interdisciplinary, Toronto), Associate Professor (Organic and Analytical Environmental Chemistry). Organic materials are present in a suite of matrices in the environment: air, water, soil, sediment and living organisms. They are produced naturally and anthropogenically. As environmental chemists we seek to understand their levels, sources, fate, persistence and global dissemination. Depending upon the project, this requires the use of any one or more of a myriad of analytical and organic techniques including spectroscopy, chromatography, computational chemistry, synthesis and mathematical modelling.

Webster, E., Ellis, D.A. **2010. "Potential Role of Sea Spray Generation in the Atmospheric Transport of Perfluorocarboxylic Acids."** Environ. Toxicol. Chem. 29(8), 1703–1708.

Woodcroft, M.W., Ellis, D.A., Rafferty, S.P., Burns, D.C., March, R.E., Stock, N.L., Trumpour, K.S., Yee, J., Munro, K. **2010. "Experimental Characterization of the Mechanism of Perfluorocarboxylic Acids' Liver Protein Bioaccumulation: The Key Role of the Neutral Species"** Environ. Toxicol. Chem. 29(8), 1669–1677.

Webster, E., Ellis, D.A., Reid, L.K. **2010. "Modeling the Environmental Fate of Perfluorooctanoic Acid and Perfluorooctanoate: An Investigation of the Role of Individual Species Partitioning."** Environ. Toxicol. Chem. 29(7), 1466–1475.

Burns, D.C., Ellis, D.A., Li, H., McMurdo, C.J., Webster, E. **2008. "Experimental pKa Determination for Perfluorooctanoic Acid (PFOA) and the Potential Impact of pKa Concentration Dependence on Laboratory-Measured Partitioning Phenomena and Environmental Modeling."** Environ. Sci. Technol. 42 (24), 9283-9288.

C. Guéguen. M.A. (Western Brittany, France), Ph.D. (Interdisciplinary, Geneva, Switzerland), Assistant Professor (Environmental Chemistry). Evaluation of environmental risks related to pollutant fate in aquatic environments is one of the central research objectives of the environmental sciences. My long-term objectives are to better understand the role of dissolved organic matter in the biogeochemical cycles of pollutants. Projects include development and application of analytical methods, water sampling, field work and speciation modeling.

Guéguen, C., McLaughlin, F.A., Carmack, E.C., Itoh, M., Narita, H., Nishino, S. **2011**. **"The nature of colored dissolved organic matter in the southern Canada Basin and East Siberian Sea"**. *Deep Sea Res. II* doi:10.1016/j.dsr2.2011.05.004

Guéguen, C., Cuss, C.W. **2011**. **"Characterization of aquatic dissolved organic matter by asymmetrical flow field-flow fractionation coupled to UV-Visible diode array and excitation emission matrix fluorescence"** *J. Chromat. A* 1218: 4188-4198

Guéguen, C., Granskog, M.A., McCullough, G., Barber, D.G. **2011. "Characterization of colored dissolved organic matter in Hudson Bay and Hudson Strait using Parallel Factor Analysis"** *J. Mar. Systems* 88: 423-433

Cuss, C.W., Guéguen, C., Dillon, P.J. **2010**. **"Spatio-temporal variation in the characteristics of disolved organic matter in the streams of boreal forests: impacts on modelled copper speciation"** *Chemosphere* 80: 764-770

H. Hintelmann, B.Sc., Ph.D. (Hamburg, Germany), Professor (Analytical Chemistry). Biogeochemical cycling of mercury, metal speciation and metal bioavailability.

Lehnherr, I., V.L. St. Louis, H. Hintelmann and J.L. Kirk. 2011. **Methylation of inorganic mercury in polar marine waters**. Nature Geoscience, DOI: 10.1038/NGEO1134.

Clarisse,O., B. Dimock, H. Hintelmann and E.P.H. Best. 2011. **Predicting net mercury methylation in sediments using diffusive gradient in thin films measurements**. Environmental Science and Technology 45:1506–1512.

Feng, X., D. Foucher, H. Hintelmann, H. Yan, T. He and G. Qiu. 2010: **Tracing mercury contamination sources in sediments using mercury isotope compositions.** Environmental Science & Technology, 44:3363-3368

Chen, J. H. Hintelmann and B. Dimock. 2010: **Chromatographic pre-concentration of Hg from dilute aqueous solutions for isotopic measurement by MC-ICP-MS.** Journal of Analytical Atomic Spectrometry, 25:1402-1409.

E.G. Lewars, B.Sc. (London), Ph.D. (Toronto), Professor (Organic Chemistry). Computational Chemistry: theoretical studies of novel molecules; prediction of chemical and physical properties of novel substances.

Computational Chemistry: Introduction to the Theory and applications of Molecular and Quantum Mechanics, Second Edition, E. Lewars, Springer, Netherlands, **2010**.

The Quinones of Benzocyclobutadiene: A Computational Study. E. Golas, E. Lewars, J. F. Liebman, *J. Phys. Chem. A*, 113, 9827-9485, **2009**.

Modeling Marvels. Computational Anticipation of Novel Molecules. E. G. Lewars, Springer, The Netherlands, **2008**.

Orthogonene redux: a nearly orthogonal alkene predicted to exhibit considerable stability. A computational study. E. Lewars, *J. Phys. Chem. A*, 109, 9827-9830, **2005**.

S.S. Narine, B.Sc., M.Sc. (Trent), Ph.D. (Guelph), Professor (Materials Science, Physics and Chemistry of Biomaterials, Physics of Crystallization and Phase Change). Research in the Trent Biomaterials Research Program is focussed on the utilization of vegetable oils (soybean, canola, flax, corn, jatropha, palm, etc.) for the synthesis of functional polymers (for use as intelligent coatings, biomedical delivery systems and other specialized polymers), lubricants, greases and waxes, nano-matrices for the delivery of bioactive compounds and fertilizers, and crystallized networks of lipids for use as healthy food materials. Activities centre on organic modification, assembly of materials at various hierarchies such as the molecular, supra-molecular and crystalline nanostructures, and structural organization at the microstructural length range, and the investigation of the relationships between the various hierarchies of structure and final macroscopic physico-chemical functionality of the materials. The materials studied are specifically designed so that their fate and functionality from cradle to cradle can be predicted and determined.

Leila Hojabri, Xiaohua Kong and Suresh S. Narine, (2010), "**Functional Thermoplastics from Linear Diols and Diisocyanates Produced Entirely from Renewable Lipid Sources**," Biomacromolecules, 11, 911–918.

Laziz Bouzidi and Suresh S. Narine, (2010), **"Evidence of critical cooling rates in non-isothermal crystallization of Triacylglycerides: A Case for the Existence and Selection of Growth Modes of a Lipid Crystal Network,"** Langmuir, 26(6), 4311–4319.

S. Abraham and S. S. Narine, (2009), "**Polynonanolactone Synthesized from Vegetable Oil: Evaluation of Physical Properties, Biodegradation and Drug Release Behavior**," Journal of Polymer Science. Part A: Polymer Chemistry, 47, 6373 – 6387

Leila Hojabri, Xiaohua Kong and Suresh S. Narine, (2009) **"Fatty acid-derived diisocyanates and biobased polyurethane produced entirely from vegetable oil: synthesis, polymerization and characterization,"** Biomacromolecules, 10, 884-891.

J.M. Parnis, B.Sc., Ph.D. (Toronto), Professor (Physical and Environmental Chemistry). Spectroscopic, kinetic, and mechanistic investigations of: tropospheric chemical intermediates and reaction branching ratios for organic trace contaminants; ion decomposition, isomerization and fragmentation products.

"Ethane Cation Decomposition Characterization by EBMI Spectroscopy: Gas-Phase Dissociative Recombination as a Source of Secondary Products"

J. Mark Parnis, Kaitlynn A. King, and Matthew G.K. Thompson, submitted to *The Journal of Mass Spectrometry,* July 06 **2011** JMS-11-0157.

"FTIR matrix isolation analysis of acetaldehyde fragmentation products following charge exchange with $Ar^{+\cdot}$ formed under varied ionization density conditions"

Matthew G. K. Thompson, Matthew R. White, Bryan D. Linford, Kaitlynn A. King, Mark M. Robinson and J. Mark Parnis. Submitted to *The Journal of Mass Spectrometry,* May **2011** JMS-11-0118

"FTIR matrix isolation study of the reaction products of vanadium atoms with propene: Observation of allylvanadium hydride as a precursor to sacrificial hydrogenation of propene"

Matthew G. K. Thompson; Stephen Walker; J. Mark Parnis, Accepted *Inorganic Chemistry* June 6, **2011** ic-2011-00934r.R2

"**Complementing PEPICO studies with the electron-bombardment matrix-isolation technique: An FTIR study of the decomposition of the vinyl fluoride cation**"

Matthew G. K. Thompson, Bryan D. Linford, and J. Mark Parnis, *J. Mass Spectrometry*, **2011**, *46*, 344-351.

S.P. Rafferty, B.Sc., (Waterloo), Ph.D. (British Columbia), Associate Professor (Biochemistry). My work centres on metalloenzymes, in particular heme proteins such as nitric oxide synthase (which some bacteria use to make nitric oxide, for reasons as yet to be explained) and flavohemoglobins (which some bacteria and single-celled eukaryotes use to consume nitric oxide, which is otherwise toxic). My most recent collaboration is with Professor Janet Yee on heme metabolism in the protozoan parasite Giardia lamblia; recently our two labs characterized the first heme protein of this organism [1].

On Sabbatical 2011-2012

Recent Peer-Reviewed Papers

Rafferty, S. P., Luu, B., March, R. E., and Yee, J. (2010) **"Giardia lamblia encodes a functional flavohemoglobin."** *Biochem Biophys Res Commun*, Accepted July 20, 2010.

Woodcroft, M. W., Ellis, D. A., Rafferty, S. P., Burns, D. C., March, R. E., Stock, N. L., Trumpour, K. S., Yee, J., and Munro, K. (2010) **"Experimental characterization of the mechanism of perfluorocarboxylic acids' liver protein bioaccumulation: The key role of the neutral species."** *Environmental Toxicology and Chemistry29*, 1669-1677.

McCarthy, S. D. S., Rafferty, S. P., and Frost, P. C. (2010) **"Responses of alkaline phosphatase activity to phosphorus stress in Daphnia magna."** *J Exp Biol213*, 256-261.

Lang, J., Driscoll, D., Gelinas, S., Rafferty, S. P., and Couture, M. (2009) **"Trp180 of endothelial NOS and Trp56 of bacterial saNOS modulate sigma bonding of the axial cysteine to the heme."** *Journal of Inorganic Biochemistry103*, 1102-1112.

I.M. Svishchev, B.Sc., M.Sc. (Moscow), Ph.D. (USSR Acad. Sciences), Professor (Physical Chemistry) Physics and Chemistry of Water; Advanced Oxidation Processes; Parallel Computing and Molecular Dynamics Simulations. Our laboratory maintains Supercritical Water Test Facility for the study of aqueous chemistry in the heat transport system of CANDU Supercritical Water-Cooled Nuclear Reactor. Research projects may also include the study of degradation of hazardous materials by "green" chemistry methods.

Plugatyr A.Y. and Svishchev I.M. **"Diffusion Coefficients of Phenol in Sub- and Supercritical Water: Application of the Split-Flow Taylor Dispersion Technique"** *J. Phys. Chem. B*, 115, 2555 -2562 (2011).

Plugatyr A.Y., Hayward T. and Svishchev I.M. **"Thermal Decomposition of Hydrazine in Sub- and Supercritical Water at 25 MPa"** *J. Supercrit. Fluids*, 55, 1014-1018 (2011).

Plugatyr A.Y. and Svishchev I.M. **"Hydration of Aniline: Analysis of Spatial Distribution Functions"** *J. Chem. Phys.*, 130, 114509 (2009).

Nahtigal I. and Svishchev I.M. **"Molecular Dynamics Study of Ionic Nanoclusters Produced from Supercritical Solutions"** *J. Supercrit. Fluids*, 50, 169-175 (2009).

A.J. Vreugdenhil, B.Sc. (Queen's), Ph.D. (McGill), Associate Professor (Inorganic Chemistry and materials). Work in the Inorganic Materials Research Laboratory revolves around the synthesis, characterization and applications of silicon hybrid organic-inorganic materials using sol-gel chemistry. Projects include development of chemically crosslinked coatings, fabrication and stabilization of nanoparticles and triggered release of small molecules from thin films and monoliths. Potential applications of our research include drug delivery systems, photoresponsive materials and "green" corrosion suppression coating systems. For more details see: http://www.trentu.ca/chemistry/avreugdenhil

On Sabbatical 2011-2012

A.J. Vreugdenhil, T.A. Singleton, "**Coatings for Corrosion Susceptible Substrates",** U.S. Patent Application, 12/605,141 (May 13, 2010).

R. Parkhill, A.J. Vreugdenhil, V.N. Balbyshev, M.S. Donley, **"Self-assembled nano-phase particle surface treatments for corrosion protection",** U.S. Patent 6,929,826, August, 2005.

A.J. Vreugdenhil, J.H. Horton, M.E. Woods, **"Fabrication, Characterization and Modification of Nanodimensional Silica Hybrid Multilayer Materials",** *J. Non-cryst. Solids,* 355, p.1206-1211 (2009) DOI:10.1016/j.jnoncrysol.2009.05.010.

A.J. Vreugdenhil, V.J. Gelling, M.E. Woods, J.R. Schmelz, B.P. Enderson, **"The Role of Crosslinkers in Epoxy-Amine Crosslinked Silicon Sol-Gel Barrier Protection Coatings",** *Thin Solid Films,* 517, p. 538-543 (2008) DOI: 10.1016/j.tsf.2008.06.073.

A.J. Vreugdenhil, K.K. Pilatzke, J.M.Parnis, **"Characterization of Laser Ablated Gold Nanoparticles Encapsulated in Epoxy Amine Crosslinked Sol-Gel Materials**", J. Non-cryst. Solids, 352, p. 3879-3886 (2006).

D. Wallschläger, Ph.D. (Bremen, Germany), Associate Professor (Environmental Chemistry). Environmental & Resource Sciences Program and Department of Chemistry. Development of analytical speciation methods for trace elements, Environmental chemistry of metalloids under anoxic conditions, Design of treatment strategies for removing metalloids from industrial waste streams, Interaction of trace element anions with algae.

Simmons, D.B.D. & Wallschläger, D. (2011): **Release of reduced inorganic selenium species into waters by the green fresh water algae *Chlorella vulgaris***, *Environ. Sci. Technol.* **45**, 2165-2171

Martin, A.J., Simpson, S., Fawcett, S., London, J., Wiramanaden, C.I.E., Pickering, I.J., Belzile, N., Chen, Y.-W. & Wallschläger, D. (2011): **Biogeochemical mechanisms of selenium exchange between water and sediments in two contrasting lentic environments,** *Environ. Sci. Technol.* **45**, 2605-2612

Wallschläger, D**.** & London, J. (2008): **Determination of methylated arsenic-sulfur compounds in ground water,** *Environ. Sci. Technol.* **42**, 228-234

Wallschläger, D. & London, J. (2005): **Determination of hexafluoroarsenate in industrial process waters by anion-exchange chromatography-inductively-coupled plasma-mass spectrometry (AEC-ICP-MS)**, *J. Anal. At. Spectrom.* 20, 993-995

Emeritus Professors

Note: For more information please see the Department of Chemistry Web Page at: http://www.trentu.ca/chemistry

Emeritus Professors potentially available for Honours Supervision:

R.E. March, B.Sc. (Leeds), Ph.D. (Toronto), D.Sc. (Leeds), D. (hc) (Provence)., F.C.I.C., Physical Chemistry. Mass Spectrometry: gaseous ion chemistry; investigation of natural compounds from plants and trees, with emphasis on flavonoids and flavonoid glycosides, by tandem mass spectrometry and NMR; development of predictive models for NMR ^{13}C chemical shifts. Investigation of tree metabolism in response to stress.

K.B. Oldham, B.Sc., Ph.D., D.Sc. (Manchester), F.R.I.C., F.C.I.C., Physical Chemistry. Electrochemistry: theory of electrochemical reactions coupled to diffusion; applications of electrochemistry, including the elucidation of reaction mechanisms, trace chemical analysis, investigation of porous matrices and precision titrations; digital data processing; modelling of transport processes.

R.A. Stairs, B.Sc., (McGill), M.Sc. (Western Ontario), Ph.D. (Cornell), C. Chem., F.C.I.C. Solutions: physical properties (viscosity, surface tension); differential solubility of minerals. Applications of statistics to solvent effects.

Support Staff

H. Al-Haddad, B.Sc. (Baghdad), Ph.D. (Strathclyde), C. Chem. Senior Demonstrator.

B. R. Best, B.Sc. (Trent), Chemical Instrumentation Technician/Demonstrator.

T. Hayward, B.Sc. (Trent), M.Sc. (Queen's), Chemical Technician

S. Landry, B.Sc. (Trent). Demonstrator.

J. LaPlante, Science Stores Manager/Chemical Technician.

Departmental Administration

Chair, ***D. Ellis***, B.Sc. (Glasgow), M.Sc. (Aberdeen), M.Sc. (Toronto), Ph.D. (Toronto),
CSB D105.1, 748-1011, Ext. 7298.

Academic/Administrative Secretary**,** ***L. LaPlante***, B.A. (Trent), B.Ed. (Queen's), CSB D105, 748-1011, Ext. 7505

Biochemistry Honours Program Co-ordinator
Chemical Physics, Chemistry and Environmental Chemistry
Honours Programs Co-ordinator**:** ***I. Svishchev***, CSB E117, 748-1011, Ext. 7063

Facilities

The teaching and research laboratories of the Department are located in the Chemical Sciences Building. In addition to the usual laboratory facilities and equipment for traditional studies in organic, inorganic, physical and analytical chemistry and biochemistry, the building houses special equipment essential for modern experimental and theoretical chemistry. Included are a variety of spectrophotometers, ion trap mass spectrometers, argon matrix isolation apparatus, gas and high performance liquid chromatography equipment.

An Honours Degree and Career Options

- An Honours Degree in Biochemistry, Chemical Physics, Chemistry or Environmental Chemistry may lead to employment in the chemical industry, for instance in pharmaceutical, biochemical and engineering companies.

- An Honours degree may lead to positions in any of a number of government departments, in research and development institutes.

- Along with teaching qualifications, it may lead to teaching in the school systems, where the need for science teachers is greater than ever before.

- An Honours Degree is the standard for full membership in the Chemical Institute of Canada, which is the professional and learned society to which most Canadian chemists belong. It is also the standard for full membership in provincial organizations, such as l'Ordre des Chimistes du Québec or the Association of the Chemical Profession of Ontario, which certify to the public the competence of their members.

- Many holders of this degree find that the training in exact thought and in resourcefulness that it has provided, stand them in good stead in fields related only remotely to chemistry, such as banking, insurance, investments, business management, law, politics and many others.

- It may lead to graduate work in any aspect of chemistry, to medicine and to other health related fields. Entry to graduate school in Chemistry in Ontario is reserved normally for holders of an Honours degree of good standard (an upper B average or better) or its equivalent. A career in scientific research and development almost always requires a doctorate, as does a teaching and research position in a university. The structure of the Honours Programs in the Department of Chemistry at Trent University with emphasis on independent work coupled with close personal contact with faculty and graduate students in ways impossible in larger universities, is excellent preparation for post-graduate work.

The Honours Programs

Biochemistry & Molecular Biology

The program in Biochemistry & Molecular Biology is a sequence of courses offered by the departments of Biology and Chemistry that comprise an integrated whole. It is not available as a joint-major degree. For information on individual courses see calendar entries for Biology and Chemistry. Students wishing to transfer to a single-major program in Biology or Chemistry should consult the chair of the appropriate department before beginning third year.

A maximum of two credits in thesis or project courses may be counted toward a Biochemistry & Molecular Biology degree. An average of 75% in all previous Chemistry and Biology courses and permission of the Co-ordinator are prerequisites for Chemistry 4030Y (Project course in Biochemistry) and Chemistry 4040D (Double credit project course in Biochemistry).

The Honours program. 20.0 credits including the following 16.5 credits:

- 3.0 BIOL credits consisting of BIOL 1020H (102H), 1030H (103H), 2000H (200H), 2050H (205H), 2070H (207H) and 3080H (308H)
- 2.0 BIOL credits from BIOL 3250H (325H), 4370H (326H), 3830H (383H), 3840H (384H), 4080H (408H), 4160H (416H), 4260H (426H), 4320H (432H), 4370H (437H), 4380H (438H); 4280H (328H) or 4280H (428H); 4600H (460H) or BIOL-PSYC 4840H (484H)
- 4.0 CHEM credits consisting of CHEM 1000H and 1010H (100); 2500H and 2510H (200); 2100H and 2110H (212); 2400H (240H) and CHEM – BIOL 2300H (231H)
- 1.0 CHEM credit from CHEM – BIOL 3300H (331H) and 3310H (332H)
- 1.0 CHEM credit from CHEM – BIOL 4300H (435H) and 4310H (436H)
- 1.0 CHEM credit at the 3000-level; or CHEM 2200H (321H) and 0.5 CHEM credit at the 3000-level.
- 3.0 BIOL or CHEM credits in addition to the above, beyond the 2000-level
- 1.0 credit in MATH 1100Y (110) or 1101Y; or in MATH 1005H (105H) and another 0.5 MATH credit
- 0.5 PHYS credit from PHYS-BIOL 1060H or PHYS 1001H

Chemical Physics

The program in Chemical Physics is a sequence of courses offered by the departments of Chemistry, Physics & Astronomy and Mathematics that comprise an integrated whole. It is not available as a joint-major degree. For information on individual courses see calendar entries for Chemistry and Physics. Students wishing to transfer to a single-major program in Chemistry or Physics should consult the chair of the appropriate department before beginning third year.

The Honours program. 20.0 credits including the following 14.0 credits:

- 3.0 CHEM credits consisting of CHEM 1000H and 1010H (or 100); 2500H and 2510H (or 200); 3500H (301H) and 3510H (302H)
- 1.0 CHEM credit from CHEM 4500H (401H), 4510H (408H), 4220H (423H), or 4400H (441H)
- 4.0 PHYS credits consisting of PHYS 1001H and 1002H (or 1000Yor 100), 2610H (202H), 2620H (203H), 3200Y (3210 or 321) and 4600Y (400)
- 3.0 MATH credits consisting of MATH 1100Y (110) or 1101Y, 2110H (201H), 2120H

(202H), 2150H (205H) and 3150H (305H)
- 2.0 CHEM, PHYS or MATH credits in addition to the above at the 4000-level
- 1.0 CHEM, PHYS or MATH credit in addition to the above, beyond the 1000-level

Chemistry

The single-major Honours degree program in Chemistry is accredited by the Canadian Society for Chemistry. A maximum of two credits may be taken in Chemistry project courses. An average of 75% in all previous Chemistry courses and the permission of the instructor are prerequisites for Chemistry 4010Y, 4020D, CHEM-BIOL 4030Y and 4040D. No more than two credits from thesis or project courses may be counted towards any degree offered wholly or jointly by the Chemistry department.

The single-major Honours program. 20.0 credits including the following 14.0 credits:
- 5.0 CHEM credits consisting of CHEM 1000H and 1010H (100); 2500H and 2510H (200); 2100H and 2110H (212); 2400H (240H); 2200H (321H); 3200H (323H) and CHEM – BIOL 2300H (231H)
- 0.5 CHEM credit from CHEM – ERSC 3400H (342H) or 3410H (343H)
- 2.0 CHEM credits in addition to the above, at the 3000-level
- 3.0 CHEM credits at the 4000-level, including at least 1.5 credits in lecture courses
- 1.0 science credit at the 4000-level or 1.0 CHEM credit at the 3000- or 4000-level in addition to the above
- 1.0 credit consisting of PHYS 1000Y (100)
- 1.0 credit from MATH 1100Y (110) or 1101Y; or from MATH 1005H (105H) and one of MATH 1350H (135H) or 1550H (155H)
- 0.5 credit in MATH or COIS in addition to the above

The joint-major Honours program. 20.0 credits including the following 8.5 credits:
- 1.0 CHEM credit consisting of either CHEM 1000H and 1010H or 100
- 2.0 CHEM credits at the 2000-level
- 2.0 CHEM credits at the 3000-level
- 2.0 CHEM credits at the 4000-level
- 1.0 MATH credit from MATH 1100Y (110) or 1101Y; or from MATH 1005H (105H) and one of MATH 1350H (135H) or 1550H (155H)
- 0.5 credit from MATH or COIS in addition to the above
- 14.0 science credits are required for the Honours degree

Environmental Chemistry

The Environmental Chemistry program is a sequence of courses offered by the Chemistry department and the Environmental & Resource Science/Studies program that comprise an integrated whole. It is not available as a joint-major degree. Students wishing to transfer to a single-major program in Chemistry or Environmental Resource Science should consult the chair of the appropriate department before beginning third year. For information on individual courses see calendar entries for Chemistry and for Environmental & Resource Science/Studies.

The Honours program. 20.0 credits which include the following 14.0 credits:
- 4.5 CHEM credits consisting of CHEM 1000H and 1010H (or 100),2500H and 2510H (or 200), 2400H (240H), CHEM-ERSC 2610H and 2620H, or 2600Y (241), 3400H (342H), 3410H (343H)

- 1.0 CHEM credit from CHEM 2100H and 2110H (or 212) for organic chemistry; or from CHEM 2200H (321H) and 3200H (323H) for inorganic chemistry
- 0.5 CHEM credit from 4510H (408H); 4400H (441H); or CHEM – ERSC 4410H (442H)
- 4.0 ERSC credits consisting of 1000Y (100), 2240H (220), 3450H (345H), 3700Y (370), 4060H (406H) and 4070H (407H)
- 2.0 CHEM or ERSC credits in addition to the above, beyond the 2000-level
- 1.0 credit from MATH 1100Y (110) or 1101Y or from MATH 1005H (105H) and another 0.5 MATH credit
- 1.0 BIOL credit consisting of BIOL 1020H (102H) and 1030H (103H)
- 1.0 MATH credit from MATH 1100Y (110) or 1101Y or from MATH 1005H (105H) and another 0.5 MATH credit.

Fourth Year Experimental Project Courses

Chemistry 4010Y - Project course in chemistry

Study, usually involving experimental research, under the supervision of a faculty member including two seminars and a written thesis. At least eight hours per week. Prerequisite or corequisite: two chemistry lecture half-courses at the 4000 (400)-level. Permission required. Contact Co-ordinator as soon as possible and no later than the end of the previous Winter session. Excludes CHEM 451.
Co-ordinator: I. Svishchev

Chemistry 4020D - Double project course in chemistry

About 16 hours per week; otherwise as Chemistry 4010. Excludes CHEM 452D. Co-ordinator: I. Svishchev

Note: An average of 75% in all previous Chemistry courses and the permission of the instructor are prerequisites for ***Chemistry 4010Y*** and ***4020D.***

Chemistry 4030Y - Project course in biochemistry

Study, usually involving experimental research, under the supervision of a faculty member, including two seminars and a written thesis. At least eight hours per week. Prerequisite or corequisite: two Chemistry or Biology lecture half-courses at the 4000 (400)-level. Permission required. Contact Co-ordinator as soon as possible and no later than the end of the previous Winter session. This course is only available to students who are pursuing the Biochemistry & Molecular Biology degree and may not be combined with more than one credit in a project course in any other discipline. Excludes CHEM 456. Co-ordinator: S. Rafferty

Chemistry 4040D - Double credit project course in biochemistry

At least 16 hours per week; otherwise as Chemistry 4030Y. May not be combined with any other project courses for credit toward the Biochemistry & Molecular Biology degree. Excludes CHEM 457D. Co-ordinator: S. Rafferty.

Note: An average of 75% in all previous Chemistry and Biology courses and permission of the Co-ordinator are prerequisites for ***Chemistry 4030Y and Chemistry 4040D***.

The Experimental Project Course

Introduction

The experimental project course is designed to introduce students to a real-life research situation. In contrast to the laboratory portions of your previous courses, the outcome of your experiments is genuinely unknown, not only to you, but also to your Supervisor. In that sense, there is no “right” or “wrong” outcome; rather, you will be attempting to answer a question such as: “Can this compound be made?” or “What is the effect of these conditions on this system?” In the process, you will doubtless encounter surprises, frustrations and even the occasional dead end. You will be expected to use creativity and common sense, as well as your Supervisor's advice, to overcome these obstacles.

Using the Literature

The published literature is one of the most powerful tools the chemist, or indeed, any scientist, has available. It forms the “institutional memory” for your field. By careful use of the literature, you will be able to form an idea of what work has already been done on your problem, and what methods may help you in finding a solution to it. You will find that there is a great deal of published material, and that it comes in a variety of forms. The one with which you are most familiar is the textbook, which usually contains a basic outline of the subject, but not much in the way of experimental detail or (usually) references. More advanced texts, such as those for upper year or graduate courses, are more helpful in this regard.

At the other extreme, we have the journal article which is a report of a specific piece of research, usually containing experimental details (sufficient to allow a reasonably skilled person to repeat the work) and references to earlier work in the area. Most new work in chemistry is first disseminated in this way. Much of the rest is first disclosed in patents. There are perhaps 10,000 journals publishing chemical articles. Journal articles come in the form of (full) papers, which are composed of an Abstract, an Introduction which sets the work in context, a Discussion section in which the results of the work are detailed, an Experimental section which gives a precise description of the actual experiments, and a Conclusion in which the main points to be drawn from the results are presented succinctly. Journal articles are usually extensively referenced. There are also shorter articles, called Notes or Communications or Letters, which are preliminary reports of new work. Communications are usually followed up by a full paper which may or may not be in the same journal. These shorter articles contain minimal experimental detail, short or no abstracts, and are thought by their authors to contain urgent results which cannot wait to be fleshed out into a full report. The contents are often republished as part of the later more-detailed publication.

Contributions to reputable journals are screened by a peer-review process. Journal editors send the contributions which they receive to other researchers working in the area or field for evaluation. These researchers are called Referees or Reviewers; they are asked to read the paper, to determine whether it should be published in the journal and to suggest corrections, changes and additional work. Referees and Reviewers base their evaluations on the quality of the work itself, its timeliness, and on the way the work is presented. They are expected to make their judgements quickly, objectively and anonymously, and not to make any use of their “prepublication” access to the results. Their recommendations are returned to the journal's editor, who decides whether the paper should be published "as is", or with modifications, or not at all. Sometimes, the editor may recommend submitting the article to another journal for whose readership or mandate is more appropriate. An active scientist may be invited to referee or review about ten articles each year.

Patents were mentioned above. Many chemical and instrumental patents are issued, and often they are the first arena for disclosure of new results, especially for researchers working for industry. A patent is supposed to disclose an invention or discovery, with full experimental details, and to make claims as to the usefulness and applications of the invention. In practice, the experimental details may not be quite complete, and the claims may be overly broad, but the patent literature is still a useful guide to previous work in some areas.

Patents and the kind of journal articles described above make up what is called the “primary literature”. That is, they are the sources closest in time and space to the actual work. Unfortunately, chemists publish an enormous amount of work, and it is difficult to keep up with the primary literature even within the narrow limits of one's own speciality. Thus we are led to the “secondary literature”.

The secondary literature is that set of sources which compile or condense reports like those described above, into a more concise form that makes it possible to find more readily information on a particular subject. Textbooks fall into this category, along with other books, including monographs, abstracting services, reviews, handbooks, and other sources. What follows is a brief description of some of the more useful of secondary literature sources.

Reviews are articles, usually rather lengthy, which summarise the work done in a particular area. The scope of the review may be limited to the period since the last such review was published, or it may go right back to the origins of the area. They are referenced copiously and may even contain some experimental details. These articles are very useful for establishing the outlines of a research area. Many journals publish reviews, and some (Chemical Reviews, Accounts of Chemical Research) are devoted exclusively to them. Other journals (Angewandte Chemie) publish one or more reviews in every issue.

Another crucial area of the secondary literature is the Abstracting Service. For chemists, the most important by far is Chemical Abstracts (CA). It publishes the abstract of almost every chemical article which appears. The abstracts are published weekly in English. CA was founded in 1907, and so it now contains an enormous amount of information. Annual indices were published until 1962, when CA went to a two volume per year format, each with an index. There are also collective indices covering a number of years (ten years until 1956, 5 years thereafter). The indices can be searched by author, chemical formula, chemical substance, general subject, patent number or registry number. Each chemical substance reported is assigned a registry number, which serves as a distinct, readily searchable identifier. For example, the registry number of sodium chloride is 7647-14-5. Access to the Chemical Abstracts is also available on-line.

Another source, called Chemical Citation Index is also available. This allows one to search the literature for papers which reference the paper or author of interest. This is, strictly speaking, a searching tool, not a component of the literature itself. In the same sense, the computer-search feature of CA, called CAS-Online, is a tool, not a literature “source”.

There are also many other secondary sources. These include (for organic chemists) Beilstein's "Handbook der Organischen Chemie", which organises the names, formulae, properties and preparations of organic compounds. There are handbooks such as the CRC Handbook of Chemistry and Physics, which is very useful for locating physical properties of organic and inorganic compounds, and a wealth of other information. One convenient (and free) source which should not be overlooked is the Aldrich Catalogue, which lists some of the properties of the over 30,000 compounds sold by that company. It also is an excellent source for quickly locating CA registry numbers. The Merck Index, now in its 12th edition, gives brief monographs on about 10,000 compounds of interest largely, but not exclusively, to the organic chemistry and pharmaceutical communities. Part of this discussion of the literature was taken from the excellent discussion found in "Advanced Organic Chemistry" by Jerry March, published by J. Wiley and Sons. This text is, incidentally, one of the best secondary sources for organic chemistry.

After the Literature Search

Once you have searched the literature, it will be necessary to sit down with your Supervisor to formulate a research plan. Your Supervisor will likely have an outline in mind already, but it will be important to contribute your own ideas. Then it is time to start the actual experimental work. Other than providing good ideas and carrying out your research using sound techniques, the most important thing that you can do to help yourself is to keep good records. Your notebook is the record of your work, often the only record, and so it should be kept meticulously. Each experiment should be described clearly, each page dated, the intent of each experiment stated clearly. All observations during the course of an experiment should be noted as the experiment is performed, along with any relevant literature references. Your Supervisor will have some idea of how the notebook should be formatted. Remember, others may have to consult your notes. If your work leads to further research projects, the notebook will be a primary source of information. You will have to use the information recorded in the notebook when you write up your project at the end of the year. After a few months, all the experiments tend to run together, so do not trust your memory.

Try to approach your experiments in a logical manner. Each experiment should have a clearly defined purpose. Make sure you have everything you need, and know what you have to do at each step, before you start. Make careful observations, and try not to let your preconceptions colour your interpretations. After all, the unexpected is what makes research interesting. Be familiar with the principles upon which your instrumentation is based, and know its limitations. Avoid the trap of overstating your conclusions; in other words, do not make any connections which are not firmly supported by the facts.

Oral and Written Presentations

At various times during the year, you will be expected to present your work to the Department. The first time will be in early October, when you will give a ten minute seminar on your project. This should consist of a brief review of the pertinent literature, to set your work in context, and an outline of what you propose to do. In other words, we should come away with an idea of where the field is now, where you would like to take it, and how you will accomplish this. At the end of the year, you will give a longer talk (fifteen-twenty minutes) describing your results, and how they compared with your earlier expectations. After both talks there will be a short question period. The question period affords an opportunity to clarify points which may not have been expressed sufficiently clearly and to explore just how well you know your topic.

When presenting your seminars, remember that the audience is usually not very familiar with the details of the field. While you may assume that we all have a basic chemistry background, you may not assume that we know the subtleties of enzyme kinetics or of gas phase ion kinetics. Visual aids are a big help here. Most students use overheads, but slides are also acceptable, and you may find that you need to use the board, especially during the question period. Whatever visual aids you may use, please make sure that they are clear and readable to the audience. Try not to block the audience's view of the screen, and do not address the screen; talk to us. Make your talk a story, with a beginning, a middle, and an end. Each talk is different, but most good speakers use an introduction that sets the work in context, and states the question that the work attempts to answer. The bulk of the talk describes the results to the questions originally posed. Remember that you know (or should know) more about this work than anyone else in the room, so tell your story clearly. Communicating results is as important as getting them. Also, try to adhere to the time limit. Too short a talk gives the impression that you do not have much to say, while a talk that goes overtime indicates that you cannot isolate the salient points and express them succinctly. Always rehearse a talk, preferably in front of an audience that can give you feedback on pace, clarity and organisation. It is not excessive to go over the talk six or seven times, until it is smooth, professional and “feels right”. When you rehearse, use your slides or overheads. Practice changing them to avoid abrupt halts in your delivery.

You will also have to give two written accounts of your work. The first, due just after Christmas, is a **Progress Report**. It should be three-four pages long, outlining how things are going, and how you intend to finish up in light of what you have learned thus far. At the end of the year, you will submit a **Final Report or Thesis**. This thesis will be written in the format of a journal article, more or less. Your Supervisor may have particular ideas on the format. The Final Report or Thesis should consist of a review of the literature, followed by a section in which you describe and discuss your results; this section is followed by a conclusions section. The experimental details may be presented in a separate experimental section. There is no set page length, but typical reports are in the neighbourhood of twenty-forty pages. The use of illustrations is encouraged. Illustrations, reaction schemes and tables should be made as clear as possible so as to enhance the “readability” of the whole work. Be very careful to avoid plagiarism in your writing. Any ideas or statements which are not your own should be properly attributed. This practice extends also to illustrations and tables copied from texts, journals or other sources.

Non-Experimental Option

Students may choose to carry out a project based on literature, rather than experimental, research. In such a case, everything which has been said thus far is still applicable. You will be expected to propose a problem to study, demonstrate a good familiarity with the area, present two talks and produce an acceptable final written report. This final report will necessarily be much longer than that resulting from an experimental project. The way in which this is accomplished will be a matter of discussion between the student and the Supervisor, with input from the Course Co-ordinator as required.

The Chemistry Seminar Series

In order to be exposed to a broader range of scientific work than is typical in a project course, students are required to attend all of the Chemistry seminars, as well as any other departmental seminars as recommended by the student's project supervisor.

Evaluation

Since this is a course, a grade is assigned. Evaluation of this kind of course is somewhat different from that of a typical lecture course. You will be marked on the oral presentations, the thesis, and your Supervisor will assign a grade which reflects your performance of the research. The thesis will be read by your Supervisor, and at least two other members of the Department. We will be looking for clarity of presentation, quality of the research itself, and an impression that you understand what you are doing, in terms of the scope and limitations of your work. The oral presentations will be graded by all the Departmental faculty, with basically the same expectations. Your Supervisor's grade will be based on an impression of your ability to understand, organise, and carry out your research. Creativity and personal initiative are important here. By the end of the course, you should be coming up with your own ideas and becoming a more independent researcher. You will be expected to devote eight-ten hours per week per credit to the project, and this will also be reflected in this mark. This portion of the grade is admittedly highly subjective, but very important in determining what you have learned from the course.

Role of the Project Course Co-ordinator

The Project Course Co-ordinator is responsible for scheduling the student seminars, arranging for readers for the papers, collecting and presenting the final marks, and doing any other tasks which fall normally to the professor in any course. The Project Course Co-ordinator is available for consultation on any problems which you may have and which cannot be solved by consultation with your Professor or Supervisor; these problems may include scheduling conflicts with the presentations, grade appeals (through the Registrar's office), equipment access problems, or anything else which may come up.

Marking Scheme

Oral Presentations:	
October Seminar	5%
April Seminar	30%
Written Reports:	
Progress Report	5%
Final Report or Thesis	30%
Supervisor's Grade	30%

Chemistry Project Course Marking Guidelines

The project course is a difficult one to evaluate, involving as it does, the comparison of subjective evaluations of dissimilar work. The following guidelines offer some suggestions as to cope with this problem.

The marking scheme for the course consists of three elements.

Written work

Written work consists of the final report, or thesis, and contributes 35% of the total mark. Written work is graded by the Supervisor, the Course Co-ordinator or his delegate, and one other reader. In assigning a grade, attention is paid to the following points:

1. Clarity; the work should be written clearly using normal grammar and punctuation and with all symbols and terms defined carefully. The thesis should be written so as to be comprehensible to a reader who is familiar with Chemistry but not necessarily an expert in the particular field of the research covered in the thesis.

2. Technical merit; the thesis should make clear the scope and limitations of the work undertaken. The thesis should illustrate the clear understanding by the student of the project subject matter and of the implications of the results described in the thesis. In particular, the student should show how the conclusions are supported by the experimental evidence; it is especially important that, when the limitations of the instrumentation are approached or exceeded, conclusions which go beyond the experimental evidence be not drawn . The student should strive to demonstrate that a good piece of scientific research has been carried out.

3. Literature awareness; the work presented in the thesis should be set in context by reference to the chemical literature. While this task is carried out mainly in the Introduction to the thesis, it may be continued in the Discussion with comparison to the results of other workers in the field.

Oral presentations

There are two oral presentations; the first is given in October and is limited to a duration of 10 minutes, and the second is given at the end of the year and is limited to 20 minutes. After each presentation there is an opportunity for questions; the durations of these question periods is approximately 5 minutes for the former and 5-10 minutes for the latter. Oral presentations contribute 35% of the total mark. Oral presentations are graded by all faculty, as well as by the student's Supervisor from another Department where appropriate. In addition to the three criteria discussed for written work above, that is, clarity, technical merit and literature awareness, the student should remember that faculty will base their evaluation on the following criteria also:

1. Pace and length: the talk must be given in the time allowed thus the material must be organised so that each of the important points is discussed in turn and at a pace which is neither rushed nor plodding.

2. Familiarity with the topic: the student must convince the audience that he/she is familiar with the topic and understands the specific area of research. Mere memorization without understanding is not acceptable.

3. Ability to answer questions: the ability to comprehend clearly posed questions and to respond succinctly to them is a valuable asset for every scientist. The student is expected to respond to reasonable questions about the work presented, the relationship of the work to other work in the field, and the conclusions drawn. It can be very useful to suggest other avenues for future research.

Conduct of research

The manner in which the research has been carried out, starting from the first exploratory interview with the prospective Supervisor and up to completion of the thesis, is judged solely by the Supervisor and contributes 30% of the total mark. Even casual conversations in the laboratory can contribute, mostly positively, to the overall evaluation of this element. The expected mark for a student who does work competently but unimaginatively usually falls in the 65-75% range; this mark is for the B-C student, or the average student, that is, one not destined for graduate school. Any student who has been accepted into a project course should not perform at a level lower than this range.

The student who is more creative and, by the end of the year, generates his or her own ideas (or who is so well informed of the literature that can suggest other paths proven by other workers in the field) falls into the 76-85%, or B-A, range. A grade of 90% (A+), is reserved for those students who have demonstrated that they are working at a level expected normally of a graduate student. A grade of 95% indicates that the student is better than nearly all of the other students that the Supervisor is likely to meet in the remainder of his/her teaching career.

Trent University Policy Statements

Academic Integrity:

Academic dishonesty, which includes plagiarism and cheating, is an extremely serious academic offence and carries penalties varying from a 0 grade on an assignment to expulsion from the University. Definitions, penalties, and procedures for dealing with plagiarism and cheating are set out in Trent University's *Academic Integrity Policy*. You have a responsibility to educate yourself – unfamiliarity with the policy is not an excuse. You are strongly encouraged to visit Trent's Academic Integrity website to learn more: www.trentu.ca/academicintegrity.

Access to Instruction:

It is Trent University's intent to create an inclusive learning environment. If a student has a disability and/or health consideration and feels that he/she may need accommodations to succeed in this course, the student should contact the Disability Services Office (Suite 132, Blackburn Hall, 705-748-1281, disabilityservices@trentu.ca) as soon as possible. Complete text can be found under Academic Support Services in the Trent University calendar.

Department Policy Statement

Chemistry Department Policy on Completion of Course Work:

The Department of Chemistry considers that completion of all components of a course is necessary for a student to be given credit in that course. Therefore, it is the policy of the Department that a student must complete, and hand in if applicable, all material associated with each component of the course. This applies equally to work that is handed in or completed too late to earn any marks in the course, in conjunction with the policy of the course instructor on lateness.

Students who fail to meet this requirement for reasons that would make it reasonable to assign an "incomplete" mark for the course should consult the instructor well before on which final marks are due for the course in question. In the absence of an incomplete standing being assigned, the student will receive a mark of "0" and an "F" grade in the course.

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