

FACULTY OF SCIENCE

SECTION CONTENTS

Personnel	322
1 Research Units	326
1.1 Centre for Earth Resources Research (CERR)	326
1.1.1 Research Group	326
1.1.2 Scope and Objectives	326
1.1.3 Organization	327
1.2 Ocean Sciences Centre (OSC)	327
2 Degree Regulations	328
2.1 Admission to the Department of Subject of Major	328
2.2 Limited Enrolment Courses	328
2.3 Regulations to Govern Supplementary Examinations in the Departments of Biochemistry, Computer Science, Mathematics and Statistics, and Physics and Physical Oceanography	328
2.4 Regulations for the General Degree of Bachelor of Science	329
2.5 Regulations for the Honours Degree of Bachelor of Science	330
3 Joint Programs	331
3.1 Biochemistry (Nutrition)/Psychology (Behavioural Neuroscience) Joint Honours	331
3.2 Biochemistry/Psychology (Behavioural Neuroscience) Joint Honours	332
3.3 Physics/Biochemistry Joint Honours	332
3.4 Chemistry/Biochemistry Joint Honours Degree	332
3.5 Cell Biology and Biochemistry Joint Honours	332
3.6 Biology and Earth Sciences Joint Honours	333
3.7 Biology/Psychology Joint Honours	333
3.8 Biology/Psychology (Behavioural Neuroscience) Joint Honours	333
3.9 Statistics/Biology Joint Honours (B.Sc. Only)	333
3.10 Joint Honours in Computer Science and Geography (B.Sc. Only)	333
3.11 Joint Honours in Computer Science and Physics	334
3.12 Joint Honours in Geography/Earth Sciences (B.Sc. Only)	334
3.13 Statistics/Computer Science Joint Honours (B.Sc. Only)	334
3.14 Earth Sciences/Chemistry Joint Honours	334
3.15 Joint Honours in Earth Sciences/Physics	335
3.16 Joint Honours in Geophysics and Physical Oceanography	335
3.17 Applied Mathematics/Chemistry Joint Honours (B.Sc. Only)	335
3.18 Pure Mathematics/Computer Science Joint Honours (B.Sc. Only)	335
3.19 Pure Mathematics/Statistics Joint Honours	335
3.20 Applied Mathematics/Physics Joint Honours	336
3.21 Physics/Chemistry Joint Honours	336
3.22 Joint Major in Computer Science and Economics (B.Sc. Only)	336
3.23 Joint Major in Computer Science and Geography (B.Sc. Only)	336
3.24 Applied Mathematics/Computer Science Joint Major (B.Sc. Only)	336
3.25 Joint Major in Pure Mathematics and Economics (B.Sc. Only)	337
3.26 Statistics/Computer Science Joint Major (B.Sc. Only)	337
3.27 Joint Major in Applied Mathematics and Economics (B.Sc. Only)	337
3.28 Joint Major in Applied Mathematics and Physics (B.Sc. Only)	337
3.29 Joint Major in Computer Science and Physics	337
3.30 Joint Major in Earth Sciences/Physics	337
3.31 Joint Major in Statistics and Economics (B.Sc. Only)	338
3.32 Joint Major in Statistics and Economics (Co-operative) (B.Sc. Only)	338
3.33 Pure Mathematics/Computer Science Joint Major (B.Sc. Only)	339
3.34 Physics/Chemistry Option Programs	339
3.35 Joint Degrees of Bachelor of Science (Computer Science) and Bachelor of Commerce (Co-operative)	339
4 Waiver of Regulations for Undergraduate Students	340
5 Program Regulations and Course Descriptions	340
5.1 Biochemistry	340
5.1.1 Programs	340
5.1.2 Admission to Programs	341
5.1.3 Biochemistry Program	341
5.1.4 Nutrition Program	342
5.1.5 Professional Program in Dietetics	343
5.1.6 Course List	344
5.2 Biology	346
5.2.1 Programs in Biology	346
5.2.2 Entrance Requirements	346
5.2.3 Minor in Biology	346
5.2.4 General Degree - Major in Biology	346
5.2.5 Honours Degrees	346
5.2.6 Honours in Biology	347
5.2.7 Course List	347
5.3 Chemistry	350
5.3.1 Programs in Chemistry	350
5.3.2 Undergraduate Handbook	351
5.3.3 Faculty Advisors	351

5.3.4	Minor in Chemistry	351
5.3.5	General Degree - Major in Chemistry	351
5.3.6	Honours Degree in Chemistry	351
5.3.7	Course Restrictions	352
5.3.8	Course List	352
5.4	Computer Science	353
5.4.1	Programs in Computer Science	353
5.4.2	Major in Computer Science	353
5.4.3	Honours in Computer Science	353
5.4.4	Honours in Computer Science (Software Engineering) (B.Sc. Only)	354
5.4.5	Computer Industry Internship Option (CIIO):	354
5.4.6	Minor in Computer Science	355
5.4.7	Course Numbering Scheme	355
5.4.8	Supplementary Examinations	355
5.4.9	Faculty Advisors	355
5.4.10	Undergraduate Handbook	355
5.4.11	Course List	355
5.5	Earth Sciences	357
5.5.1	Programs in Earth Sciences	357
5.5.2	Undergraduate Handbook	358
5.5.3	Entrance Requirements	358
5.5.4	Minor in Earth Sciences	358
5.5.5	Major Programs in Earth Sciences	358
5.5.6	Honours B.Sc. Degree in Earth Sciences	358
5.5.7	General B.Sc. Degree in Earth Sciences	359
5.5.8	Course List	360
5.6	Economics	362
5.7	Geography	363
5.7.1	Programs in Geography	363
5.8	Mathematics and Statistics	363
5.8.1	Programs in Mathematics and Statistics	363
5.8.2	Regulations	363
5.8.3	Faculty Advisors	364
5.8.4	Course Numbering System	364
5.8.5	Major in Applied Mathematics (B.Sc. Only)	364
5.8.6	Major in Pure Mathematics	364
5.8.7	Major in Statistics	364
5.8.8	Honours in Applied Mathematics (B.Sc. Only)	364
5.8.9	Honours in Pure Mathematics	364
5.8.10	Honours in Statistics	365
5.8.11	Minor in Mathematics	365
5.8.12	Minor in Statistics	365
5.8.13	Course List	365
5.9	Physics and Physical Oceanography	368
5.9.1	Programs in Physics	368
5.9.2	Minor in Physics	369
5.9.3	Major in Physics	369
5.9.4	Honours in Physics	369
5.9.5	Major in Environmental Physics	370
5.9.6	Honours in Environmental Physics	370
5.9.7	Course List	371
5.10	Psychology	373
5.10.1	Programs in Psychology	373
5.10.2	Admission to Major and Minor Programs	373
5.10.3	Admission to Honours Programs	374
5.10.4	Requirements for a Major in Psychology	374
5.10.5	Requirements for Honours in Psychology	374
5.10.6	Requirements for a Major in Behavioural Neuroscience (B.Sc. Only)	374
5.10.7	Requirements for Honours in Behavioural Neuroscience (B.Sc. Only)	375
5.10.8	Requirements for a Minor in Psychology	375
5.10.9	Course Descriptions	375
5.11	Science	377

List of Tables

Academic Course Program - Joint Major in Statistics and Economics (Co-operative) Table	339
Bachelor of Commerce (Co-operative) Curriculum (Completed Jointly with The Degree of Bachelor of Science with a Major in Computer Science) Table	340
Table of Credit Restrictions for Present Earth Sciences Courses with Former Courses	359
Table of Credit Restrictions for Present Physics Courses with Former Courses	371

Dean

Lucas, C.R., B.Sc., M.Sc. *Acadia*, D.Phil. *Oxon*, F.C.I.C.; Professor of Chemistry

Associate Dean (Administration and Undergraduate)

Gardner, G.A., B.Sc. *Guelph*, M.Sc., Ph.D. *British Columbia*; Associate Professor of Biology

Associate Dean (Research)

Courage, M.L., B.A. *Memorial*, M.Sc. *University of Alberta*, Ph.D. *Memorial*; Professor (Psychology); Cross appointment to the Discipline of Pediatrics, Faculty of Medicine

Manager, Finance & Administration

Gosse, Charles, C.M.A.

DEPARTMENT OF BIOCHEMISTRY**Head**

Mulligan, M.E., B.Sc.(Hons.) *National University of Ireland*, Ph.D. *Harvard*; Winner of the President's Award for Distinguished Teaching, 1999; Professor

Professores Emeriti

Keough, K.M.W., B.Sc.(Hons.), M.Sc., Ph.D. *Toronto*
Mookerjea, S.S., B.Sc., M.Sc., Ph.D. *Calcutta*

Professors

Brosnan, J.T., B.Sc.(Hons.), M.Sc., D.Sc. *National University of Ireland*, D.Phil. *Oxford*; University Research Professor, Awarded 1990
Brosnan, M.E., B.A.(Hons.), M.Sc., Ph.D. *Toronto*; Cross appointment with Faculty of Medicine
Davis, P.J., B.Sc., Ph.D. *Memorial*; Special Advisor to Associate Vice-President (Academic)
Heeley, D.H., B.Sc.(Hons.), Ph.D. *Birmingham*; Deputy Head (Graduate and Research)
Herzberg, G.R., B.S., Ph.D. *Maine*
Hoover, R., B.Sc.(Hons.) *Ceylon*, M.Sc. *Leeds*, Ph.D. *Alberta*
Hulan, H.W., B.Sc.(Hons.), M.Sc. *McGill*, Ph.D. *Maine*
Martin, A.M., B.E., D.Ch.E. *Havana*, M.C.I.C.
Rahimtula, A.D., M.Sc. *Bombay*, Ph.D. *Southampton*; Deputy Head (Undergraduate)
Robinson, J.J., B.Sc.(Hons.) *University College Dublin*, M.Sc. *Trinity College Dublin*, Ph.D. *Alberta*
Shahidi, F., B.Sc. *Shiraz*, Ph.D. *McGill*, University Research Professor, Awarded 1998; Cross appointments with Ocean Sciences Centre and the Department of Biology

Associate Professors

Ghazala, S., B.Sc. *Baghdad*, Dip.Mech.Eng., M.Sc. Mech. Eng. *University of Technology, Baghdad*, Ph.D. *McGill*
Kaur, S., B.Sc. *Punjab*, M.Sc. *Punjab Agricultural*, Ph.D. *Post Graduate Institute of Medical Education and Research*; Cross appointment with Faculty of Medicine
Liu, H., B.Sc.(Pharm.), M.Sc.Pharm. *Beijing Medical*, Ph.D. *Alberta*; Cross appointment from School of Pharmacy
McGowan, R.A., B.Sc.(Hons.) *Brock*, Ph.D. *SUNY, Buffalo*; Joint appointment with Department of Biology
Randell, E.W., B.Sc.(Hons.), Ph.D. *Memorial*; Cross appointment from Faculty of Medicine
Roebathan, B., B.Sc.(Hons.) *Memorial*, M.Sc. *Saskatchewan*, Ph.D. *Memorial*; Joint appointment with Faculty of Medicine

Assistant Professors

Bertolo, R.F.P., B.A.Sc., (Hons.) *McMaster*, M.Sc., Ph.D., *Guelph*; Canada Research Chair in Human Nutrition
Booth, V.K., B.Sc.(Hons.) *Victoria*, M.Sc. *Waterloo*, Ph.D. *Toronto*; Canada Research Chair in Proteomics; Cross appointment with Department of Physics and Physical Oceanography
Brunton, J.A., B.A.Sc. *Guelph*, Ph.D. *McMaster*
MacPhee, D.J., B.Sc.(Hons.) *Prince Edward Island*, Ph.D. *Western Ontario*; Cross appointment from Faculty of Medicine
Nag, K., B.Sc.(Hons.), M.Sc. (Part I) *Calcutta*, M.Sc., Ph.D. *Memorial*; Cross appointment with Department of Physics and Physical Oceanography
Volkoff, H., B.Sc. *Pierre and Marie Curie University*, M.Sc. *University of Aix-Marseille III*, Ph.D. *Clemson University*; Joint appointment with Department of Biology

Adjunct Professors

Hamoutene, D.H., B.Sc. *Hourari Boumediene*, M.Sc., Ph.D. *Aix-Marseille II*
Payne, J.F., B.Sc., M.Sc., Ph.D. *Memorial*

Administrative Assistant

Sinnott, A.L., B.Com., MBA *Memorial*

Amino Acid Laboratory Supervisor

Skinner, C.T.

Senior Technician, Student Laboratory

Murphy, M.J., B.Sc., B.Ed. *Memorial*

Supply Supervisor

Murphy, H.L.

DEPARTMENT OF BIOLOGY**Head**

Marino, P., B.A. *Vermont*, M.Sc. *Northern Arizona*, Ph.D. *Alberta*

Professores Emeriti

Bal, A.K., B.Sc., M.Sc., Ph.D. *Calcutta*
Burton, D., B.Sc. *Wales*, P.G.C.E., Ph.D. *London*
Haedrich, R.L., A.B., A.M., Ph.D. *Harvard*; University Research Professor, Awarded 1999; Cross appointments with Ocean Sciences Centre and Department of Earth Sciences
Khan, R.A., B.S.A., M.Sc., Ph.D. *Toronto*
Steele, D.H., B.Sc. *Western Ontario*, M.Sc., Ph.D. *McGill*

Honorary Research Professors

Burton, M., B.Sc., Ph.D. *London*; Cross appointment with Ocean Sciences Centre
Colbo, M., B.Sc., M.Sc. *Alberta*, Ph.D. *Queensland*
Green, J.M., B.Sc. *Michigan*, M.Sc. *Miami*, Ph.D. *British Columbia*
May, A.W., B.Sc.(Hons.), M.Sc. *Memorial*, Ph.D. *McGill*, DU *Ottawa*, D.Sc. *Memorial*, LL.D. *Brock*

Professors

Carr, S.M., B.Sc. *California Polytechnic*, C.Phil., Ph.D. *University of California, Berkeley*; Cross appointment to Faculty of Medicine
Collins, M.A.J., B.Sc., Cert. Ed., M.Sc. *Southampton*, B.Ed., M.Ed. *Memorial*, Ph.D. *Keele*; Winner of the President's Award for Distinguished Teaching, 1996-1997; Associate Vice-President (Academic) (on leave)
Dickinson, A.B., B.Sc. *London*, B.Ed., M.Sc. *Memorial*, M.A.(Ed.) *Leeds*, M.Phil., Ph.D. *Cambridge*; Executive Director (Acting) CCIFTD (on leave)
Finney-Crawley, J.R., B.Sc. *Wales*, M.Sc., Ph.D. *London*; Winner of President's Award for Distinguished Teaching 2000-2001
Gow, J.A., B.Sc. *Guelph*, M.Sc. *Western Ontario*, Ph.D. *McGill*
Innes, D., B.Sc. *British Columbia*, M.Sc. *Dalhousie*, Ph.D. *S.U.N.Y.*

Associate Professors

Dunbrack, R., B.A. *New Brunswick*, Ph.D. *Simon Fraser*
Emerson, I.P., B.Sc. *Toronto*, B.Ed., M.Sc. *Memorial*; First Year Co-ordinator
Gardner, G.A., B.Sc. *Guelph*, M.Sc., Ph.D. *British Columbia*; Associate Dean of Science (on leave)
Hermanutz, L., B.Sc. *Guelph*, M.Sc. *Windsor*, Ph.D. *Western Ontario*; Cross appointment with Botanical Garden
Hooper, R.G., B.Sc. *Victoria*, Ph.D. *Portsmouth*; Curator, Phycological Herbarium; Director, Bonne Bay Marine Station; Cross appointment to Sir Wilfred Grenfell College
Jones, I.L. B.Sc. *Carleton*, M.Sc. *Toronto*, Ph.D. *Queen's*
Knoechel, R., B.Sc., *Cornell*, Ph.D. *McGill*
McGowan, R.A., B.Sc.(Hons.) *Brock*, Ph.D. *SUNY/AB*; Joint appointment with Department of Biochemistry
Miller, E.H., B.Sc. *Alberta*, M.Sc. *Canterbury*, Ph.D. *Dalhousie*
Murrin, F., B.Sc. *Memorial*, M.Sc. *Acadia*, Ph.D. *Queen's*
Pickavance, J.R., B.Sc., Ph.D. *Liverpool*
Scott, P.J., B.Sc. *Alberta*, Ph.D. *Memorial*; Curator, Agnes Marion Ayre Herbarium
Snelgrove, P., B.Sc.(Hons.) *Memorial*, M.Sc. *McGill*, Ph.D. *Woods Hole*; Joint appointment with Ocean Sciences Centre
Staveley, B.E., B.Sc., M.Sc. *Guelph*, Ph.D. *Alberta*

Assistant Professors

Edinger, E., B.A. *California*, M.Sc., Ph.D. *McMaster*; Joint appointment with Department of Geography
Lang, A.S., B.Sc.(Hons.) *Brock*, Ph.D. *British Columbia*
Volkoff, H., B.Sc. *Pierre et Marie Curie University*, M.Sc. *University of Aix-Marseille III*, Ph.D. *Clemson University*; Joint appointment with Department of Biochemistry
Wiersma, Y.F., B.Sc.(Hons.), B.Ed. *Toronto*, M.Sc., Ph.D. *Guelph*

Adjunct Professors

Anderson, M.R., B.Sc., M.Sc. *Larval*, Ph.D. *McGill*
 Barker, D., B.Sc.(Hons.), M.Sc. *Memorial*, Ph.D. *Dalhousie*
 Carscadden, J.E., B.Sc., M.Sc. *Waterloo*, Ph.D. *McGill*
 Chen, Y., B.Agric.(Fish.Sci.) *Qingdao*, M.Sc., Ph.D. *Toronto*
 Debnath, S., B.Sc.Ag.(Hons.), M.Sc.Ag. *Bangladesh Agric. Univ.*,
 Ph.D. *India Agric. Res. Inst.*
 Dixon, P.L., B.Sc. *Memorial*, M.Sc. *Guelph*, Ph.D. *Edinburgh*
 Fraser, G., B.Sc. *Minnesota*, M.Sc. *North Dakota*, Ph.D. *Memorial*
 Gibson, R. John Gibson, B.S., M.A. *Trinity College, Dublin Univ.*,
 B.Sc., M.Sc. *Western Ontario*, Ph.D. *Waterloo*
 Gregory, R.S., B.Sc.(Hons.) *Acadia*, M.Sc. *Trent*, Ph.D. *British*
Columbia
 Hicks, B., B.Sc.(Hons.), M.Sc. *Memorial*, Ph.D. *Univ. Edinburgh*
 Kaunda-Arara, B., B.Sc. *Moi*, M.Sc. *Nairobi*, Ph.D. *Memorial*
 McKenzie, D.B., B.S.A., M.Sc. *Manitoba*, Ph.D. *Texas A & M*
 McLaren, B., B.Sc. *Toronto*, Ph.D. *Michigan Tech. Univ.*
 Mehl, K., B.Sc. *Humbolt College*, M.Sc. *Texas A & M*, Ph.D.
Saskatchewan
 Methven, D.A., B.Sc. *Mt. Allison*, M.Sc., Ph.D. *Memorial*
 Robertson, G.J., B.Sc. *Queens*, Ph.D. *Simon Fraser*
 Ryall, K., B.Sc.(Hons.) *Queen's*, M.Sc., Ph.D. *Toronto*
 Schaefer, J.A., B.Sc. *McGill*, M.Sc. *Manitoba*, Ph.D. *Saskatchewan*
 Stenson, G.B., B.Sc. *Alberta*, Ph.D. *British Columbia*
 Van Zyll de Jong, M.C., B.Sc. *Toronto*, M.Sc., Ph.D. *Hull*
 Whitney, H.G., B.Sc. *McGill*, M.Sc. *Saskatchewan*, Ph.D. *Montréal*

Cross Appointments

Deibel, D., B.Sc. *Bucknett*, Ph.D. *Georgia*; University Research
 Fellow, Associate Professor (Research); Winner of the
 President's Award for Outstanding Research, 1990-1991; Cross
 appointment from Ocean Sciences Centre
 Driedzic, W.R., B.Sc. *York*, M.Sc. *Toronto*, Ph.D. *British Columbia*;
 Cross appointment from Ocean Sciences Centre
 Fleming, I.A., B.Sc. *Queen's*, M.Sc. *Simon Fraser*, Ph.D. *Toronto*;
 Cross appointment from Ocean Sciences Centre
 Fletcher, G.S., B.Sc. *British Columbia*, Ph.D. *California*; Professor
 (Research); Cross appointment from Ocean Sciences Centre
 Gamperl, A.K., B.Sc. (Hons.), M.Sc. *Guelph*, Ph.D. *Dalhousie*;
 Cross appointment from Ocean Sciences Centre
 Mercier, A., B.Sc. *Université de Sherbrooke*, M.Sc., Ph.D.
Université du Québec à Rimouski; Cross appointment from
 Ocean Sciences Centre
 Nicholls, K.W., B.Sc.(Hons.) *Univ. College of Wales*, Ph.D. *British*
Columbia; Cross appointment from Botanical Garden
 Parrish, C.C., B.Sc. *Wales*, Ph.D. *Dalhousie*; Winner of the
 President's Award for Outstanding Research, 1995-1996; Cross
 appointment from Oceans Sciences Centre
 Patel, J.T., B.Sc., M.Sc. *Majaraja Sayajirao*, M.S. *Texas Women's*,
 Ph.D. *S.U.N.Y. (Buffalo)*; Cross appointment from Fisheries and
 Marine Institute
 Rivkin, R.B., B.Sc., M.Sc. *City College, New York*, Ph.D. *Rhode*
Island; Cross appointment from Ocean Sciences Centre
 Rose, G.A., B.Sc. *Guelph*, M.Sc. *Laurentian*, Ph.D. *McGill*; Cross
 appointment from Fisheries and Marine Institute
 Schneider, D.C., B.Sc. *Duke*, Ph.D. *SUNY, Stony Brook*; Associate
 Dean (Research); Professor; Cross appointment from Ocean
 Sciences Centre; Cross appointment with Department of
 Psychology
 Shahidi, F., B.Sc. *Shiraz*, Ph.D. *McGill*; Cross appointment from
 Department of Biochemistry
 Thompson, R.J., B.Sc. *Bristol*, Ph.D. *Leicester*; Professor
 (Research); Cross appointment from Ocean Sciences Centre
 Wroblewski, J.S., B.Sc. *Illinois*, M.Sc., Ph.D. *Florida State*;
 Professor (Research); Cross appointment from Ocean Sciences
 Centre

Administrative Staff Officer

Cramm, M., B.Ed.(Post Secondary) *Memorial*

Supervisor of Laboratories

Collins, G.

DEPARTMENT OF CHEMISTRY**Head**

Davis, R.W., B.Sc. *Memorial*, Ph.D. *British Columbia*; Associate
 Professor

Professor Emeritus

Anderson, H.J., M.Sc. *Manitoba*, Ph.D. *Northwestern*, F.C.I.C.

Honorary Research Professor

Gogan, N.J., B.Sc.(Hons.), Ph.D. *National University of Ireland*,
Dublin, F.C.I.C.

Professors

Bodwell, G.J., B.Sc., M.Sc. *Victoria*, Dr.rer.nat. *Tech. Univ.*
Braunschweig; Winner of the President's Award for Outstanding
 Research, 1998-1999; Winner of the Petro Canada Young
 Innovator Award, 1999-2000
 Georghiou, P.E., B.Sc.(Hons.) *Witwatersrand*, Ph.D. *McGill*,
 F.C.I.C.
 Helleur, R.J., B.Sc. *Concordia*, M.Sc. *McGill*, Ph.D. *Queen's*; Cross
 appointment with Ocean Sciences Centre
 Jablonski, C.R., B.Sc. *Mass.*, Ph.D. *Calgary*, F.C.I.C.; Winner of
 the President's Award for Outstanding Research, 1984-1985;
 Interim Dean of Graduate Studies
 Lucas, C.R., B.Sc., M.Sc. *Acadia*, D.Phil. *Oxon*, F.C.I.C.; Dean of
 Science
 Mezey, P.G., M.Sc., M.Sc., Ph.D. *Budapest*, D. Sc. *Saskatchewan*;
 Canada Research Chair in Scientific Modelling and Simulation
 Pickup, P.G., B.A., D.Phil. *Oxon*; Deputy Head (Graduate Studies
 and Research); University Research Professor, Awarded 2005
 Poirier, R.A., B.Sc., M.Sc. *Laurentian*, Ph.D. *Toronto*, F.C.I.C.;
 Winner of the President's Award for Outstanding Research,
 1986-1987
 Thompson, L.K., B.Sc., Ph.D. *Manchester*, F.C.I.C.; University
 Research Professor, Awarded 1995

Associate Professors

Flinn, C.G., B.Sc., M.Sc., Ph.D. *Dalhousie*
 Mackey, M.D., B.Sc. *British Columbia*, M.Sc., Ph.D. *Guelph*

Assistant Professors

Bottaro, C.S., B.Sc.(Hons.) *St. Mary's*, Ph.D. *Dalhousie*
 Fridgen, T.D., B.Sc.(Hons.) *Trent*, B.Ed., Ph.D. *Queen's*
 Kerton, F.M., B.Sc.(Hons.) *Univ of Kent*, D.Phil. *Univ of Sussex*
 Kozak, C.M., B.Sc.(Hons.) *McMaster*, Ph.D. *UBC*
 Merschrod, E., A.B. *Bryn Mawr Coll.*, M.S., Ph.D. *Cornell*
 Pansare, S.V., B.Sc., M.Sc., *Univ. Pune (India)*, Ph.D. *Alberta*
 Thompson, D.W., B.Sc.(Hons.), M.Sc. *Queen's*, Ph.D. *York*
 Zhao, Y., B.S., M.S. *Dalian*, Ph.D. *Alberta*

Assistant Professor (term)

Hattenhauer, K.M., B.Sc. *Winnipeg*, Ph.D. *Manitoba*

Cross-Appointment

Parrish, C.C., B.Sc. *Wales*, Ph.D. *Dalhousie*; Cross appointment
 from Ocean Sciences Centre

Adjunct Professors

Banoub, J.H., B.Sc.(Hons.) *University of Alexandria, Egypt*, Ph.D.
University of Montreal
 Miller, D., B.Sc., M.Sc. *Memorial*

Administrative Officer

Corbett, L.

Director, CREAT Network

Miller, D., B.Sc., M.Sc. *Memorial*

Chemistry Stores Supervisor

Ballard, S.

Undergraduate Laboratory Supervisor

Gulliver, G.

DEPARTMENT OF COMPUTER SCIENCE**Head**

Banzhaf, W., Dipl. Phys. *Ludwig-Maximilian*, Munich, Dr.rer.nat
Friedericiana, Karlsruhe; Professor

Professors

Bartha, M., M.Sc., Ph.D. *József Attila University, Hungary*
 Gillard, P., B.Sc., M.Sc., Ph.D. *Memorial*
 Lu, S., B.Eng. *Peking*, M.Sc., Ph.D. *Waterloo*
 Miminis, G., Dipl. Greek Center of Productivity, B.Sc. *Univ. of*
Ioannina (Greece), M.Sc., Ph.D. *McGill*; Chair, Computational
 Science Program
 Tang, J., M.Sc. *Iowa*, Ph.D. *Penn. State*
 Vidyasankar, K., M.Tech. *I.I.T. Kanpur*, Ph.D. *Waterloo*
 Wang, C.A., B.A. *Peking*, M.Sc., Ph.D. *Alberta*
 Zuberek, W., M.Sc., Ph.D., D.Sc. *Warsaw Tech.*

Associate Professors

Brown, E., B.Sc.(Hons.), *Memorial*, M.Sc. *U. of T.*, Ph.D. *Toronto*, LL.B. *Victoria*
 Byrne, R., B.Sc.(Hons.), B.Eng. *Memorial*, M.Sc., Ph.D. *Victoria*
 Deb, A., M.Tech. *Calcutta*, Ph.D. *Iowa*
 Fiech, A., Dipl. Inf. *Dortmund*, Ph.D. *Kansas State*
 Shieh, J., B.Sc. *Beijing*, M.Sc., Ph.D. *Simon Fraser*
 Wareham, T., B.Sc.(Hons.), B.A., M.Sc. *Memorial*, Ph.D. *Victoria*
 Yu, G., M.Sc. *Northeastern*, Ph.D. *London*

Assistant Professors

Bungay, S., B.Sc., M.Sc. *Memorial*, Ph.D. *Guelph*
 Chen, Y.P., B.Sc. *Beijing*, Ph.D. *Simon Fraser*
 Mata-Montero, M., B.Sc. *Costa Rica*, M.Sc. *Illinois*, Ph.D. *Victoria*
 Vardy, A., B.Eng. *Memorial*, M.Sc. *Sussex*, Ph.D. *Carleton*; Joint appointment with Electrical and Computer Engineering, Faculty of Engineering and Applied Science

Lecturers

Batten, D.L., B.Sc.(Hons.) *Memorial*, M.Sc. *Queen's*
 Gupta, R., B.A. *Agra Univ.*, B.A. *Memorial*, M.S. *Georgia Tech.*
 Zuberek, M., B.Eng., M.Sc. *Warsaw Tech.*

Cross-Appointments

Norvell, T.S., B.Sc.(Hons.) *Dalhousie*, M.Sc., Ph.D. *Toronto*; Cross appointment from Faculty of Engineering and Applied Science
 Parsons, J., B.Comm.(Hons.) *Memorial*, Ph.D. *British Columbia*; Cross appointment from Faculty of Business Administration
 Peters, D.K., B.Eng. *Memorial*, M.Eng., Ph.D. *McMaster*, P.Eng.; Cross appointment from Faculty of Engineering and Applied Science
 Pike, D., B.Math. *Waterloo*, MAM, Ph.D. *Auburn*, FTICA; Cross appointment from Department of Mathematics and Statistics

Systems Manager

Rayment, M., B.Sc. *Memorial*, MS *M.I.U.*

Systems Personnel

Boland, T., B.Sc. *Memorial*, AITD, ITI
 Hart, D., B.Sc., Dipl. IT *Memorial*
 Price, P., B.Sc. *Memorial*
 White, N., B.Sc. *Memorial*, MS *M.I.U.*
 Wissink, M., B.Sc. *New Brunswick*
 Young, J., B.Sc. *Memorial*

Laboratory Instructor

Johnstone, S., B.Sc. *Memorial*

Instructional Assistants

Anthony, S., B.Sc. *Memorial*
 Milley, C., B.Sc. *Memorial*
 Verbree-Barnes, I., B.Sc. *Memorial*

Computer Industry Internship Co-ordinator

Jackson, W., B.A. *Mount Allison*, M.A. *Bradford*

Administrative Staff Specialist

Boone, E.

DEPARTMENT OF EARTH SCIENCES**Head**

Hanchar, J.M., B.S. *Memphis*, M.S. *Vanderbilt*, Ph.D. *Rensselaer Polytechnic Institute*

Professores Emeriti

Hodych, J.P., M.A., Ph.D. *Toronto*
 Longerich, H., B.Sc. *Millikin*, Ph.D. *Indiana*
 Rochester, M.G., B.A., M.A. *Toronto*, Ph.D. *Utah*, F.R.S.C.; University Research Professor, Awarded 1986

Honorary Research Professor

Williams, H., M.Sc. *Memorial*, Ph.D. *Toronto*; F.R.S.C.

University Research Professor

Hall, J., B.A. *Oxon*, DIC *London*, Ph.D. *Glasgow*, P.Geo.; University Research Professor, Awarded 2003

Professors

Aksu, A.E., B.Sc. *Ege*, M.Sc., Ph.D. *Dalhousie*, P.Geo.
 Burden, E.T., B.Sc., M.Sc. *Toronto*, Ph.D. *Calgary*, P.Geo.
 Dunning, G.R., B.Sc., M.Sc. *Carleton*, Ph.D. *Memorial*; Winner of the President's Award for Outstanding Research, 1994-1995
 Gale, J.E., B.A.(Ed.), B.Sc. *Memorial*, M.Sc. *Western Ontario*, M.Eng.Sci., Ph.D. *Berkeley*, P.Geo.; Winner of the President's

Award for Outstanding Research, 1985-1986
 Hiscott, R.N., B.Sc. *Brock*, Ph.D. *McMaster*, P.Geo.
 Indares, A., B.Sc. *Grenoble*, M.Sc., Ph.D. *Montreal*
 Jenner, G.A., B.Sc., M.Sc. *Western Ontario*, Ph.D. *Tasmania*, P.Geo.
 Johansen, T., BaSc., M.Sc., Ph.D. *Oslo*; Canada Research Chair in Reservoir Engineering; Cross appointment with Faculty of Engineering and Applied Science
 Miller, H.G., B.Sc., M.Sc. *Memorial*, Ph.D. *British Columbia*, P.Geo.
 Quinlan, G.M., B.Sc. *Toronto*, Ph.D. *Dalhousie*, P.Geo.
 Rivers, C.J.S., B.Sc. *Belfast*, Ph.D. *Ottawa*, P.Geo.
 Slawinski, M.A., B.Sc., M.Sc., Ph.D. *Calgary*; Petro Canada Chair in Applied Seismology
 Sylvester, P.J., B.S. *Purdue*, Ph.D. *Washington*
 Wilton, D.H.C., B.Sc. *Memorial*, M.Sc. *British Columbia*, Ph.D. *Memorial*, P.Geo.
 Wright, J.A., B.A.Sc., M.Sc., Ph.D. *Toronto*, P.Geo.; Director, Major Research Partnerships

Associate Professors

Azmy, K., B.Sc. *Ain Shams*, M.Sc. *Windsor*, Ph.D. *Ottawa*
 Bentley, S.J., B.A. *Magna Cum Laude*, *University of Georgia*, M.S. *University of Georgia*, Ph.D. *SUNY Stony Brook*; Canada Research Chair in Seabed Processes and Seabed Imaging
 Bording, R.P., B.S. *Missouri*, M.S. *Alabama*, Ph.D. *Tulsa*; Husky Energy Chair in Oil and Gas Research
 Calon, T.J., M.Sc., Ph.D. *Leiden*, P.Geo.
 Enachescu, M.E., M.Sc., Ph.D. *Bucharest*; Husky Energy Senior Research Fellow in Exploration Geophysics
 Hurich, C., B.Sc., M.Sc., Ph.D. *Wyoming*
 Layne, G.D., B.Sc., Ph.D. *University of Toronto*
 Leitch, A., B.Sc., Ph.D. *Australian National*, NSERC WFA
 Mason, R.A., B.Sc. *London*, Ph.D. *Aberdeen*, P.Geo.
 Meyer, R., B.A. *Lawrence*, M.Sc. *Michigan State*, Ph.D. *Calgary*
 Wilson, M.R., B.Sc.(Hons.), Ph.D. *Sask.*
 Ziegler, S., B.S. *University of Massachusetts*, Ph.D. *University of Texas*; Canada Research Chair in Environmental Science

Assistant Professors

Bóna, A., B.Sc.(Hons) *Czech Technical University*, Ph.D. *Calgary*
 Jamieson, R., B.Sc., M.Sc. *Memorial*, Ph.D. *McMaster*
 McIlroy, D., B.Sc. *Manchester*, D.Phil. *Oxford*; Canada Research Chair in Petroleum Geoscience and Geotechnology

Visiting Assistant Professor

Bucataru, I., M.Sc., Ph.D. "AC.I. Cuza" of Iasi

Adjunct Professors

Cabri, L.J., B.Sc.(Hons.) *Witwatersrand*, M.Sc.(Appl.), Ph.D. *McGill*; Emeritus Research Scientist (CANMET, NRC)
 Farquharson, C., B.Sc.(Hons.) *University of Edinburgh*, Ph.D. *University of British Columbia*
 Scott, W.J., B.A.Sc., M.A. *Toronto*, Ph.D. *McGill*, P.Eng., P.Geo., FGAC

Post-Doctoral Fellows

Bennett, V., B.Sc. *Macquarie University*, Ph.D. *Memorial*
 Welford, J.K., B.Sc. *McGill*, M.Sc., Ph.D. *British Columbia*

Manager of Academic Programs

Miskell, M., B.Sc. (Hons.) *Memorial*

Research Computing Specialist

Thomeier, D., B.Sc.(Hons.), B.A. *Memorial*

Laboratory Instructor

Hicks, R., M.Sc. *Dalhousie*

Administrative Officer

Penney, M., B.Comm., C.M.A., M.B.A. *Memorial*

DEPARTMENT OF MATHEMATICS AND STATISTICS**Head**

Radford, C., B.Sc., Ph.D. *Sydney*

Professor Emeritus

Shawyer, B.L.R., B.Sc., Ph.D. *St. Andrews*, C.Math., F.I.M.A.(U.K.)

Honorary Research Professors

Booth, P.I., B.Sc., M.Sc., Ph.D. *Hull*; Winner of the Dean of Science Distinguished Scholar Medal, 1996

Brunner, H., M.A., Ph.D., E.T.H. *Zurich*; University Research Professor, Awarded 1994

MATHEMATICS

Professors

Bahturin, Y., D.Sc., Ph.D. *Moscow*, University Research Professor, Awarded 2002
 Campbell, H.E.A., B.Sc., M.Sc. *Memorial*, Ph.D. *Toronto*; Vice-President (Academic) and Pro Vice-Chancellor
 Goodaire, E.G., B.Sc. *Toronto*, Ph.D. *British Columbia*, Graduate Officer
 Heath, P.R., B.Sc., Ph.D. *Hull*, DBS *Durham*, MTS *Queen's*
 Kocabiyik, S., B.Sc., M.Sc. *Middle East Tech.*, Ph.D. *Western Ontario*; Petro-Canada Young Innovators Award, 2000
 Parmenter, M.M., B.Sc. *Toronto*, Ph.D. *Alberta*; Motivational Teaching Award, 2003
 Shalaby, N.A.I., M.A. *York*, Ph.D. *McMaster*
 Summers, D., B.Sc., Ph.D. *London*, F.I.M.A. (U.K.); University Research Professor, Awarded 2000
 Watson, B., B.A., M.A., Ph.D. *Western Ontario*
 Zhao, X., B.S., M.S. *Northwest*, Ph.D. *Academia Sinica*

Associate Professors

Foster, A., B.Sc., Ph.D. *Dalhousie*, M.Math. *Waterloo*; Motivational Teaching Award, 2001
 Mantyka, S., B.A., M.B.A. *Sask.*, M.Math., Ph.D. *Waterloo*
 Pike, D., B.Math. *Waterloo*, MAM, Ph.D. *Auburn*, FTICA; Motivational Teaching Award, 2004
 Rees, R.S., B.Sc., B.Med.Sc., Ph.D. *Queen's*, FTICA; Hall Medal, 1999
 Suvak, J.A., B.S. *St. Martin's College*, M.S., Ph.D. *Arizona*
 Xiao, J., M.Sc. *Hunan*, Ph.D. *Peking*
 Yuan, Y., B.Sc. *Wuhan*, M.Sc. *Central South Univ. of Tech.*, Ph.D. *Western Ontario*; UFA 2004
 Zhou, Y., B.Sc. *Hunan Normal*, M.Sc. *Beijing Normal*, Ph.D. *British Columbia*

Assistant Professors

Booth, I., B.Sc. *Memorial*, M.Sc., Ph.D. *Waterloo*; Cross appointment to Department of Physics and Physical Oceanography
 Dyer, T.D., B.Sc.(Hon.) *Memorial*, M.Sc., Ph.D. *Simon Fraser*
 Kondratieva, M., M.Sc. *Moscow Inst. of Electronics & Math*, Ph.D. *Tomsk State*; Joint appointment with Faculty of Education
 Kotchetov, M., M.Sc. *Moscow State (Lomonosov)*, Ph.D. *Memorial*, Cand. Sc. *Moscow State*
 Merkil, M., Diploma in Theoretical Physics, *EPF Lausanne*, Ph.D. *Toronto*
 Ou, C.-H., B.A. *Peking*, Ph.D. *Hong Kong*
 Sadov, S., M.Sc. *Moscow Inst. of Electronics and Math*, Ph.D. *Keldysh Inst. for Applied Math*

Adjunct Professor

Charron, R.J., B.Sc. *New Brunswick*, M.Math. *Waterloo*, Ph.D. *New Brunswick*; Motivational Teaching Award, 1999

Laboratory Instructor

O'Reilly, G., B.Sc. *Memorial*

STATISTICS

Professor

Sutradhar, B.C., B.Sc. *Dacca*, M.Sc. *Dacca and Western Ontario*, Ph.D. *Western Ontario*; University Research Professor, Awarded 2004

Associate Professors

Oyet, A., B.Sc., M.Sc. *Fed. U. of Tech.*, Ph.D. *Alberta*
 Peng, P., B.Sc., M.Sc. *Lanzhou*, Ph.D. *Newcastle*
 Wang, H., B.Sc. *Beijing Normal*, Ph.D. *Regina*

Assistant Professors

Fan, Z., B.Sc., M.Sc. *Shandong*, Ph.D. *Gottingen*
 Loredo-Osti, J.C., B.Sc., M.Sc. *Universidad Autonoma*, Ph.D. *Dalhousie*
 Sneddon, G., B.Sc.(Hon.) *Acadia*, M.Sc., Ph.D. *Dalhousie*; Motivational Teaching Award, 2005

Adjunct Professor

Cadigan, N., B.Sc., MAS *Memorial*, Ph.D. *Waterloo*

Cross-Appointment

Gadag, V., B.Sc., M.Sc. *Karnatak*, M.Phil., Ph.D. *Poona*; Professor of Biostatistics, Cross appointment from Department of Health

Statistics and Health Information Systems

Consultants for Master of Applied Statistics Program

Bartholomew, L., B.Sc., M.A.S. *Memorial*; Newfoundland Statistical Agency
 Cadigan, N., B.Sc., M.A.S. *Memorial*, Ph.D. *Waterloo*; Department of Fisheries and Oceans, St. John's
 Lye, L.M., B.Sc.(Hons.) *Bolton Inst.*, Ph.D. *Manitoba*, P.Eng.; Faculty of Engineering and Applied Science, Memorial University of Newfoundland
 Schneider, D.C., B.Sc. *Duke*, Ph.D. *SUNY, Stony Brook*; Ocean Sciences Centre, NICOS
 Thompson, R.J., B.Sc. *Bristol*, Ph.D. *Leicester*; Ocean Sciences Centre, Logy Bay
 Tsoa, E.Y., B.A. *Taiwan*, M.A., Ph.D. *Notre Dame*; Department of Economics, Memorial University of Newfoundland

Undergraduate Officer

Johnson, H., B.Sc. *Memorial*

Administrative Staff Specialist

English, R.

DEPARTMENT OF PHYSICS AND PHYSICAL OCEANOGRAPHY

Head

de Young, B., B.Sc., M.Sc. *Memorial*, Ph.D. *British Columbia*; Appointed to Robert A. Bartlett Professorship in Oceanography; Winner of the President's Award for Outstanding Research, 1997-1998; Cross appointment with Ocean Sciences Centre; Professor

Professores Emeriti

Cho, C.W., B.Sc. *Seoul*, M.A., Ph.D. *Toronto*
 Clouter, M.J., M.Sc. *Memorial*, Ph.D. *Toronto*; University Research Professor, Awarded 2000
 Gien, T.T., Lic. és Sc. *Saigon*, M.Sc., Ph.D. *Ohio*; University Research Professor, Awarded 2001
 Reddy, S.P., M.Sc., D.Sc. *Andhra*, F. Inst. P. *London*, F.A.P.S.
 Rochester, M.G., M.A. *Toronto*, Ph.D. *Utah*, FRSC; University Research Professor, Awarded 1986; Cross appointment from Department of Earth Sciences

Professors

Lagowski, J.B., B.Sc. *Manitoba*, M.Sc., Ph.D. *Toronto*
 Lewis, J.C., B.Sc., M.Sc. *Carleton*, Ph.D. *Toronto*
 Morrow, M.R., B.Sc. *McMaster*, M.Sc., Ph.D. *British Columbia*
 Plumer, M., B.Sc. *St. Francis Xavier*, M.Sc. *Dalhousie*, Ph.D. *Toronto*
 Whitehead, J.P., B.Sc. *St. Andrew's*, Ph.D. *Alberta*

Associate Professors

Afanassiev, I., Ph.D. *P.P. Shirshov Institute of Oceanology, Russian Acad.*, M.Sc. *Moscow Physical-Technical University* (on leave)
 Curnoe, S.H., B.Sc. *Toronto*, Ph.D. *British Columbia* (NSERC UFA); Winner of the President's Award for Outstanding Research, 2005-2006
 Quirion, G., B.Sc., M.Sc., Ph.D. *Sherbrooke* (on leave)
 Zedel, L., B.Sc., M.Sc. *Victoria*, Ph.D. *British Columbia*; Petro-Canada Young Innovators Award, Awarded 2001

Assistant Professors

Andrews, G.T., B.Sc., M.Sc., Ph.D. *Memorial*
 Beaulieu, L., B.Sc. *University of Ottawa*, M.Sc., Ph.D. *Dalhousie*
 Bourgault, D., M.Sc. *Quebec at Rimouski*, Ph.D. *McGill*
 Chen, Q., B.Sc. *Shanghai Jiao Tong University China*, M.Sc., Ph.D. *Shanghai Institute of Optics and Fine Mechanics, China* (CRC Photonics)
 Demirov, E., M.Sc., Ph.D. *University of St. Petersburg, Russia*
 Poduska, K., B.A. *Carleton College*, M.S., Ph.D. *Cornell*
 Saika-Voivod, I., B.Sc.(Hons.), Ph.D. *University of Western Ontario*
 Yethiraj, A., B.Sc. *Bombay (St. Xavier's College)*, M.Sc. *Houston*, Ph.D. *Simon Fraser*

Adjunct Professors

DeBell, K., B.Sc. *King's College, University of London*, M.Sc. *Westfield College, University of London*, Ph.D. *University of London*
 Han, G., B.S., M.S., Ph.D. *Hohai University*
 Whitmore, M.D., B.Sc., M.Sc., Ph.D. *McMaster*

Cross-Appointments

Booth, I., B.Sc.(Hons.) *Memorial*, M.Sc., Ph.D. *University of Waterloo*; Cross appointment from Department of Mathematics and Statistics
 Booth, V., B.Sc. *Victoria*, M.Sc. *Waterloo*, Ph.D. *Toronto*; Cross appointment from Department of Biochemistry
 Mezey, P., M.Sc., Ph.D. *University of Budapest*, D.Sc. *University of Saskatchewan*; Canada Research Chair; Cross appointment from Department of Chemistry
 Nag, K., B.Sc.(Hons.) *University of Calcutta*, M.Sc., Ph.D. *Memorial*; Cross appointment from Department of Biochemistry
 Wroblewski, J.S., B.Sc. *Illinois*, M.Sc., Ph.D. *Florida State*; Cross appointment from Ocean Sciences Centre

Administrative Officer

Corbett, D.

Laboratory Co-ordinator

Deacon, C.G., Ph.D. *Birmingham*, MBA *Memorial*

Cryogenics Officer

Holly, W.

DEPARTMENT OF PSYCHOLOGY**Head**

Neath, I., B.A. *Rice University*, M.S., Ph.D. *Yale*; Professor

Honorary Research Professors

Evans, J.H., B.A., Ph.D. *Wales*; Associate Professor
 Kozma, A., M.A., Ph.D. *Western Ontario*

Professors

Adamec, R.E., B.A. *Middlebury*, M.A., Ph.D. *McGill*; University Research Professor, Awarded 1993; Cross appointment with Faculty of Medicine
 Adams, R.J., B.A. *Concordia*, Ph.D. *McMaster*; Cross appointment with Faculty of Medicine
 Button, C.M., B.Sc., M.Sc. *Memorial*, Ph.D. *Rhode Island*
 Courage, M.L., B.A. *Memorial*, M.Sc. *Alberta*, Ph.D. *Memorial*; Cross appointment with Faculty of Medicine
 Grant, V.L., B.A., M.A. *Toronto*, Ph.D. *Memorial*
 Harley, C.W., B.S. *San Francisco State*, M.S., Ph.D. *Oregon*; Cross appointment with Faculty of Medicine
 McKim, W.A., B.A. *Memorial*, M.A. *Toronto*, Ph.D. *Western Ontario*
 Malsbury, C., B.A. *Northwestern*, M.A., Ph.D. *McGill*; Cross appointment with Faculty of Medicine
 Martin, G.M., B.Sc.(Hons.), M.Sc. *Memorial*, Ph.D. *Australian National University*
 Montevicchi, W.A., B.A. *Northeastern*, M.Sc. *Tulane*, Ph.D. *Rutgers*; Cross appointments to Ocean Sciences Centre and Department of Biology; University Research Professor, Awarded 2005
 Penney, C., B.Sc.(Hons.) *McGill*, M.A., Ph.D. *Toronto*
 Peterson, C., B.S. *Washington*, Ph.D. *Minnesota*; University Research Professor, Awarded 2006
 Rabinowitz, F.M., B.A., M.S. *Rensselaer*, Ph.D. *Iowa*
 Sherrick, M.F., B.A., M.A., Ph.D. *Cincinnati*; Winner of the President's Award for Distinguished Teaching, 1992-1993
 Storey, A.E., B.Sc., M.A. *Manitoba*, Ph.D. *Rutgers*
 Walker, Lilly J. Shubert, B.A. *Jamestown College*, M.A., Ph.D. *University of North Dakota*; Dean, Student Affairs and Services

Associate Professors

Anderson, R.E., B.A. *Wisconsin*, Ph.D. *California*

1 Research Units**1.1 Centre for Earth Resources Research (CERR)****Director**

Hanchar, J.M., B.S. *Memphis*, M.S. *Vanderbilt*, Ph.D. *Rensselaer Polytechnic Institute*

1.1.1 Research Group

The Centre draws on the research expertise of faculty and research staff members in the Department of Earth Sciences as well as other specialists inside and external to the University. For a complete listing of faculty, see Earth Sciences entry.

1.1.2 Scope and Objectives

The CERR was established in 1983 to provide for the co-ordination and promotion of earth resources research and associated work related to the origin, discovery, development, exploitation, and environmental aspects of earth resources.

The Centre promotes, initiates, and co-ordinates research within the earth resources disciplines on the national and international

Andrews, E.A., B.A., B.Sc., M.Sc. *Memorial*
 Arlett, C., B.Sc. *Leicester*, M.A., Ph.D. *British Columbia*
 Gosse, V., B.A., M.Ed. *Memorial*, M.Sc. *Memorial*
 Grant, M., B.A., M.A. *Toronto*
 Maddigan, R.I., B.A.(Hons.), M.Sc. *Memorial*; Co-ordinator, First Year
 Penney, R., B.A.(Hons.) *Memorial*, M.A., Ph.D. *Michigan State*, M.F.T. *Hahnemann*; Cross appointment to Counselling Centre
 Skinner, D.M., B.Sc.(Hons.) *Memorial*, Ph.D. *Toronto*
 Strawbridge, J., B.A., M.A. *Carleton*, Ph.D. *Queen's*
 Surprenant, A.M., B.A. *New York*, M.S., Ph.D. *Yale*

Assistant Professors

Fowler, K.F., B.Sc.(Hons.), Ph.D. *Memorial*
 Francis, S.E., B.A. *State University of New York at Albany*, M.A., Ph.D. *Hawaii*
 Hadden, K., B.A.(Hons.) *York*, M.A., Ph.D. *Saskatchewan*
 Hannah, E.R., B.Sc. *Buenos Aires*, M.A. *SUNY at Stony Brook*
 Mezo, P.G., B.Sc.(Hons.) *Toronto*, M.A., Ph.D. *Hawaii*
 Snook, B., B.A. *Memorial*, M.Sc., Ph.D. *Liverpool*
 Walsh, C.J., B.Sc.(Hons.) *Memorial*, M.A. *Toronto*, Ph.D. *Memorial*

Adjunct Professors

Garthe, S., B.Sc. *Hamburg*, M.Sc., Ph.D. *Kiel*
 Gilchrist, H.G., B.Sc.(Hons.) *Trent*, Ph.D. *British Columbia*
 Koen-Alonso, M., Ph.D. *Buenos Aires*
 Sjare, B.L., B.Sc.(Hons.) *Alberta*, M.Sc. *McGill*, Ph.D. *Alberta*

Cross Appointments

Canning, P.M., B.A.(Hons.) *UPEI*, M.A., Ph.D. *Univ. of Windsor*; Cross appointment from Faculty of Education
 Corbett, D., B.A. *Dalhousie*, M.Sc. *Memorial*, Ph.D. *Concordia*; Cross appointment from Faculty of Medicine
 Hurley, G., B.A. *Colorado College*, M.S., Ph.D. *Missouri Columbia*; Cross appointment from Counselling Centre
 Murray, P.M., B.Sc.(Hons.) *Ulster*, Ph.D. *Stirling*; Cross appointment from Faculty of Medicine
 Schneider, D.C., B.S. *Duke*, Ph.D. *SUNY at Stony Brook*; Cross appointment from Ocean Sciences Centre

Administrative Staff Specialist

Rose, S.

Laboratory Instructors

Brown, A., B.A. (Hons.) *Memorial*
 Milway, S., B.A. *Concordia*

Instructional Assistant

Gaborko, L., B.Sc. *Trent*

Research Computing Specialist

Earle, A., B.Sc. *Memorial*

SCIENCE 1150/1151**Associate Professor**

Smith, F.R., B.Sc., M.Sc. *Memorial*; Co-ordinator

Laboratory Instructor

Huelin, S., B.Sc., M.Sc., B.Ed.

scenes. Researchers interact, when appropriate, with the industrial and government sectors and introduce other organizations to the potential benefits of further research and development in earth resources.

The special facilities of the Centre complement the development of graduate and undergraduate programs in earth sciences and related disciplines at Memorial University of Newfoundland. A further function of the Centre is to contribute to the training of people competent in solving earth resources problems and to encourage personnel exchanges with industry and government.

The Alexander Murray Building houses the Centre, and has laboratories for teaching and basic and applied research.

1.1.3 Organization

The Centre is an integral part of the Department of Earth Sciences. The active research of faculty members contributes to programs in the Centre. Increasing collaboration is under way with government and industry in research projects that emphasize earth resources. The work of the Centre addresses problems and opportunities related to mineral resources, petroleum resources, exploration technology, environmental geoscience, and generic research.

The Centre works closely with other local, national, and international research institutes. CERR hosts the geoscience component of the University's Oil and Gas Development Partnership.

1.2 Ocean Sciences Centre (OSC)

Administration

Boyce, D., B.A., M.Sc. *Memorial*; Aquaculture Development Supervisor, Aquaculture Research and Development Facility

Devereaux, J.; Field and Laboratory Services Supervisor

Fleming, I.A., B.Sc. *Queen's Univ.*, M.Sc. *Simon Fraser Univ.*, Ph.D. *Univ. of Toronto*; Associate Professor and Director, Ocean Sciences Centre

Nichols, D., B.A., MMS. *Memorial*; Research Marketing Manager

Wheeler, D.; Staff Administrative Specialist, Finance

Scientific Staff

Deibel, D.R., B.Sc. *Bucknell University, U.S.A.*, Ph.D. *University of Georgia, U.S.A.*; Professor; Cross appointment with Department of Biology

Driedzic, W.R., B.Sc. *York, M.Sc. Toronto*, Ph.D. *British Columbia*; Professor; Tier I Canada Research Chair in Marine Bioscience; Cross appointments with Departments of Chemistry and Biochemistry

Gamperl, A.K., B.Sc., M.Sc. *Guelph*, Ph.D. *Dalhousie*; Associate Professor; Cross appointment with Department of Biology

Mercier, A., B.Sc. *Université de Sherbrooke*, M.Sc., Ph.D. *Université du Québec à Rimouski*; Assistant Professor

Parrish, C.C., B.Sc. *Wales*, Ph.D. *Dalhousie*; Winner of the President's Award for Outstanding Research, 1995-1996; Professor

Rise, M., M.Sc. *Boston College, U.S.A.*, Ph.D. *University of Victoria*; Assistant Professor; Tier II Canadian Research Chair in Marine Biotechnology

Rivkin, R.B., B.Sc., M.Sc. *City College, New York*, Ph.D. *Rhode Island*; Professor; Cross appointment with Department of Biology

Schneider, D.C., B.Sc. *Duke*, Ph.D. *SUNY, Stony Brook*; Professor; Associate Dean (Research), Faculty of Science; Cross appointments with Departments of Biology and Psychology

Snelgrove, P.V.R., B.Sc. *Memorial*, M.Sc. *McGill*, Ph.D. *Woods Hole*; Associate Professor; Tier 2 Canada Research Chair in Boreal and Cold Ocean Systems; Cross appointment with Department of Chemistry; Joint appointment with Department of Biology

Thompson, R.J., B.Sc. *Bristol*, Ph.D. *Leicester*; Professor (Research); Cross appointment with Department of Biology

Wroblewski, J.S., B.Sc. *Illinois*, M.Sc., Ph.D. *Florida State*; Professor (Research); Cross appointment with Department of Biology

Professores Emeriti

Burton, D., B.Sc. *Wales*, Ph.D. *London*; Biology

Fletcher, G.L., B.Sc. *British Columbia*, Ph.D. *California*

Khan, R.A., B.SA, M.Sc., Ph.D., *Toronto*; Biology

Adjunct Professors

Afonso, L., B.Sc. *Brazil*, M.Sc. *Fed. Univ. of Rio Grande do Sul, Brazil*, Ph.D. *Univ. of British Columbia*; NRC, Halifax

Anderson, J.T., B.Sc., M.Sc. *Guelph*, Ph.D. *British Columbia*; Department of Fisheries and Oceans

Cote, D., M.Sc. *Wilfrid Laurier Univ.*, Ph.D. *Univ. of Waterloo*; Terra Nova National Park

Dixon, B., B.Sc. *Wilfrid Laurier Univ.*, M.Sc. *Univ. of Guelph*, Ph.D. *Dalhousie Univ. of Waterloo*

Ewart, K., B.Sc. *Moncton*, Ph.D. *Memorial*; Associate Research Officer, National Research Council - Institute for Marine Biosciences, Halifax

Johnson, S.C., B.Sc. *Victoria*, M.Sc. *Dalhousie*, Ph.D. *Simon Fraser*; Associate Research Officer, National Research Council - Institute for Marine Biosciences, Halifax

Mansour, Atef, B.Sc., M.Sc., Ph.D. *Cario Univ.*; Research Scientist, Dept. of Fisheries and Oceans, St. John's, NL

McKenzie, C., B.Sc., Ph.D. *Texas A & M*; Department of Fisheries and Oceans

McKinley, S., B.Sc. *Guelph*, M.Sc. *York*, Ph.D. *Waterloo*; NSERC Industrial Chair and Canada Research Chair; Professor, Faculty of Agricultural Sciences, University of British Columbia

Morgan, J.M., B.Sc. *Mount Alison*, Ph.D. *Queen's*; Department of Fisheries and Oceans

Pepin, P., B.Sc. *McGill*, Ph.D. *Dalhousie*; Northwest Atlantic Fisheries Centre, Department of Fisheries and Oceans

Walsh, S., B.Sc., M.Sc. *Memorial*, Ph.D. *Univ. of Bergen, Norway*; Department of Fisheries and Oceans

Cross-Appointed Faculty

Dr. M.P. Burton; Department of Biology

Dr. W. Montevecchi, Department of Psychology

Dr. F. Shahidi; Department of Biochemistry

Dr. H. Volkoff; Department of Biology

Post-Doctoral Fellows

Adams, B., B.Sc. *St. Mary's Univ.*, M.Sc., Ph.D. *Dalhousie Univ.*

Heibo, E., M.Sc. *University of Oslo, Norway*, Ph.D. *Umeaa, Sweden*

Trela, P., M.Sc. *Gdansk University, Poland*, Ph.D. *Dalhousie*

Research Associate

Puvanendran, V., B.Sc. *Sri Lanka*, Ph.D. *Memorial*

Research Specialist

DuRand, M., Ph.D. *Massachusetts*

Research Assistants

Ings, D., M.Sc. *Memorial*

Jones, D., B.Sc. *Saskatchewan*

King, M.J., B.Sc. *Memorial*

Short, C., B.Sc. *Memorial*

The Ocean Sciences Centre (OSC) provides scientists at Memorial University of Newfoundland and other organizations with first-rate facilities for research in cold ocean sciences. In addition, the OSC supports quality graduate education in a broad range of marine science and related disciplines. Located on the most eastern coast of Canada the Centre lends itself to the shore-based study of cold ocean processes, and sub-arctic and arctic fauna and flora. Current research foci are aquaculture, biological and chemical oceanography, and fundamental principles of behaviour, biochemistry, and physiology that underlie the first two themes. The OSC is a key player in AquaNet, Canada's first federal Network of Centres of Excellence (NCE) devoted to aquaculture. The OSC is an AquaNet Core Facility, as well as its Administrative Centre.

Located at Logy Bay, 9.6 km from the main campus, the OSC has an excellent unpolluted sea water supply that is the lifeline of the centre. There are 35 laboratories (22 provided with running seawater) and facilities for microscopy, histochemistry, analytical chemistry, radioisotope counting, physiological work, and standard analyses for oceanography. Large holding areas permit scientists to maintain a variety of marine organisms for long periods at ambient and controlled water temperatures. The Seal Research Facility offers research opportunities on North America's only population of captive harp seals. The Field Services Unit provides extensive resources for field studies including: year round SCUBA diving, small research vessels, a tank truck for the transportation of live specimens, and a wide-range of oceanographic and collecting equipment.

The Logy Bay complex includes machine, woodworking and electronics shops, computer resource personnel, and a multimedia classroom. Desktop computers are linked to the mainframe cluster on campus, with high-resolution printing and graphics, and an image analysis facility.

The Aquaculture Research and Development Facility provides state-of-the-art facilities designed to support research, training, pre-commercial production, and small-scale commercial trials, on alternative species for marine aquaculture. A critical component of the new facility is a sea water system designed to deliver high quality, temperature controlled, flow through and re-circulating water. There are areas for broodstock conditioning, hatchery and nursery operation, first-feeding, on-growing, and live food production. Under investigation are: Atlantic halibut, Atlantic cod, Atlantic salmon and smaller flounder species.

Research Themes

1. Aquaculture nutrition and production
2. Reproductive biology of finfish and molluscs
3. Development and behavioral ecology of larval and juvenile fish
4. Survival of marine organisms without oxygen
5. Antifreeze proteins and cold adaptation in fish
6. Biological production and the ecology of cold oceans
7. Transport and fate of lipids in cold ocean ecosystems
8. Physiology of feeding and digestion in marine invertebrates
9. Marine biotechnology
10. Fisheries oceanography
11. Quantitative biology and population interactions

2 Degree Regulations

2.1 Admission to the Department of Subject of Major

Admission to certain major programs within the Faculty is limited and competitive.

Admission to all major programs within the Faculty is upon formal application to the department of the subject of major after completion of the admission requirements.

Unless otherwise indicated by the Departmental Admission Regulations as published in the University Calendar under departmental regulations, students upon formal application by *Change of Academic Program Form*, are normally admitted to the department of major program upon successful completion of 30 credit hours which must include:

1. Six credit hours in English courses
2. Six credit hours in Mathematics courses
3. Six credit hours in courses from each of two Sciences other than Mathematics

Students seeking admission to departments with Departmental Admission Regulations as indicated above must apply for admission on the appropriate Departmental Application for Admission Form upon completion of the specified admission requirements.

2.2 Limited Enrolment Courses

Certain course offerings in the Faculty of Science will be identified as being Limited Enrolment Courses and will be clearly identified as such in the University Timetable. Students who have registered for a Limited Enrolment Course must confirm their registration either (1) by attending at least one of the first three hours of lecture in the course and the first meeting of any laboratory section of the course; or (2) by notifying the department in writing within the first five university working days of the semester. Students who do not confirm their registration may be dropped from the course on the recommendation of the Head of Department.

2.3 Regulations to Govern Supplementary Examinations in the Departments of Biochemistry, Computer Science, Mathematics and Statistics, and Physics and Physical Oceanography

1. Supplementary examinations will be allowed in certain of the Biochemistry, Computer Science, and Physics and Physical Oceanography courses, and all Mathematics and Statistics courses which have written final examinations. In each course, students will be informed as to the possibility of a supplementary examination during the first week of classes. This information will be provided in writing, as part of the evaluation scheme for the course.
2. Supplementary examinations will be similar in length and degree of difficulty as the original final examination.
3. Students who wish to write supplementary examinations must apply in writing to the department within one week of release of

grades.

4. A student who has clear or conditional standing may write a supplementary examination in a course if the final grade obtained is 45-49F and if his or her term mark is at least 50%.
5. In order to pass the course, the student, must pass the supplementary examination. If the student passes the supplementary examination, then a new grade will be calculated using the same weighting scheme as used in the course, but with the result of the supplementary examination replacing that of the original final examination. Any additional course requirements, including a requirement to pass the laboratory component of a course, will continue to apply.
6. If the new course grade is higher than the original, it will replace the original grade on the student's transcript, subject to the condition that the final mark will not exceed the student's term mark. The student's transcript will indicate that the course result was earned as the result of a supplementary examination.
7. Supplementary examinations will be written no later than the first week of the semester immediately following the one in which the course was failed. Normally they will coincide with the writing of deferred examinations. Grades for supplementary examinations will be submitted to the Office of the Registrar within one week following the commencement of classes for that semester.
8. A student may write a supplementary examination for any one registration in a course only once; if the course result following the supplementary examination is a fail then the course must be repeated in order to obtain credit.

2.4 Regulations for the General Degree of Bachelor of Science

1. For the General Degree of Bachelor of Science a candidate will be required to complete, subject to the following Regulations, 120 credit hours applicable to the degree which shall include:
 - a. Six credit hours in English courses
 - b. Six credit hours in Mathematics courses
 - c. Six credit hours in courses from each of two Sciences other than Mathematics
2.
 - a. Courses shall be chosen so that a candidate shall have completed an approved concentration of courses in one subject to be known as the candidate's Major. In selecting courses in their Major, candidates must comply with the Departmental Regulations approved by the Senate and printed in the Calendar. The Departmental Regulations shall require not fewer than 36 nor more than 45 credit hours in courses from the subject of the Major (including the courses in that subject completed at the first year level). (See also Notes 1. and 2.).
 - b. The subject of the candidate's major shall be that declared by the candidate on the appropriate admission form and approved by the department at the time of admission.
 - c. The 36 or more credit hours in courses from one subject referred to in a. above, may be chosen from the following subjects, and may include courses in that subject which were completed at first-year level: Biology (see Note 4.), Biochemistry (see Note 6.), Chemistry, Computer Science, Earth Sciences, Economics, Geography, Mathematics (except 1150, 1151) and Statistics, Physics, Psychology.
 - d. A candidate may change the subject of the Major during any Regular Registration Period provided he or she has first applied for and received acceptance by the department to which application is being made.
 - e. In those Departments which offer programs leading to both a degree of Bachelor of Arts and a degree of Bachelor of Science, students are free to choose the degree program they wish to follow and may change from one to the other; however, they may not obtain both degrees in the same Major subject at this University. Students who are concurrently completing the Bachelor of Commerce (Co-operative) degree should refer to the entry Joint Degrees of Bachelor of Science (Computer Science) and Bachelor of Commerce (Co-operative) immediately following these regulations.
3. Further courses may be chosen from any of the subjects listed in Clause 2. above, or from other courses approved by the Committee on Undergraduate Studies of the Faculty of Science (see Note 5.), provided that, of the 120 credit hours required:
 - a. candidate shall have completed at least 78 credit hours in courses from the subjects listed in Clause 2. above, including the Major courses and the courses required for admission; See Notes 3. and 5.
 - b. there shall be not fewer than five subjects in which a candidate shall have completed courses. At least four of these subjects shall be chosen from the subjects listed in Clause 2. above. In the case of unspecified transfer credits awarded in a subject area not taught at Memorial University of Newfoundland any number of such transfer credits in the aggregate shall count as one subject area.
 - c. not more than 15 unspecified transfer credit hours awarded in a subject area not taught at Memorial University of Newfoundland shall be used to satisfy the requirements of the degree.
4. Before a candidate registers, the Head of the Department of his or her Major, or delegate, shall approve a candidate's program which is in accordance with the above regulations. The Head of the Department or delegate shall advise each candidate of programs suitable for his or her particular needs.
5. To obtain a general degree of Bachelor of Science a candidate shall have:
 - a. satisfied the conditions of **UNIVERSITY REGULATIONS - General Academic Regulations (Undergraduate), Graduation under Application for Graduation - Degrees, Diplomas and Certificates;**
 - b. obtained an average of at least 2.0 points per credit hour in the 78 credit hours in Science required for the degree;
 - c. obtained an average of at least 2.0 points per credit hour in the minimum number of credit hours in the major subject (or, in the case of joint majors, subjects) required for the major program (or, in the case of joint majors, programs).
6. Where a student satisfies the separate departmental regulations for a major in two or more subjects for which a specific joint program does not exist, such subjects shall be recognized as the major subjects for the general degree of Bachelor of Science.
7. A candidate may complete a minor of at least 24 credit hours in courses from a subject area other than that of the Major chosen from Clause 2. c. above or from minors available in the Faculty of Arts, the Faculty of Business Administration, and the School of Music. (It should be noted that because of departmental regulations for the Major, not every candidate may be able to fit a minor into his or her 120 credit hour program).
 - a. The subject of the candidate's minor shall be that declared by the candidate on the Change of Academic Program Form which must then be signed by the Head of the Department of the Minor.
 - b. A candidate must follow the departmental regulations for the Minor as set forth in the appropriate section of the Calendar.
 - c. The Head of the Department of the Minor will advise the candidate on the selection of courses in the Minor.
 - d. Students who have taken courses appropriate to their Minor at another university are required to complete at least 6 credit hours in courses from that subject at this University. These courses must be chosen in consultation with the Head of the Department of

the Minor program.

- e. A candidate must obtain a grade point average of at least 2.0 in the credit hours prescribed for the minor program.

Notes: 1. *Departmental regulations are not intended to debar students from taking more than the required courses in the subject of their Major.*

2. *Students who have taken courses in the subject of their Major at another university are required to complete at least 12 credit hours in courses from that subject at this University.*
3. *Science 2010/2011 may be used to fulfil in part the requirement of 78 credit hours in Science.*
4. *Biology 2120 may not be used for credit by Biology Majors.*
5. *When Science course equivalents have been established by Department Heads for Engineering courses, credit may not be obtained for both the Engineering course and the established equivalent course offered by the Faculty of Science.*
6. *In the case of Biochemistry the courses for the Biochemistry program shall include Chemistry 2400 and 2401.*

2.5 Regulations for the Honours Degree of Bachelor of Science

A program is offered leading to the Honours Degree of Bachelor of Science. An Honours degree offers greater specialization in a given field of knowledge than a General degree, and requires higher than average academic achievement. Possession of this degree will be of great advantage to all students planning more advanced work in their chosen field. In many cases, an Honours degree is a prerequisite for admission to a graduate program.

1. Admission and Registration

- a. Declaration of Intent: A candidate for an Honours degree shall declare in writing his (her) intention to pursue an Honours program and to obtain an Honours degree in a specified subject or subjects. Such declaration shall be submitted to his (her) Department(s) of specialization and to the Registrar not earlier than the beginning of his (her) fifth semester, or the equivalent, at University, and not later than the final date set for the application for a degree. A candidate for an Honours degree must have completed all courses listed under **Admission to the Department of Subject of Major** before declaring his (her) intent to pursue an Honours degree, regardless of whether these courses had been completed at the time of admission to his (her) Department of specialization.

Note: *An otherwise qualified student who fails to declare his (her) intention to obtain an Honours degree on or before the last day of the period outlined above shall be awarded a General degree even if he (she) fulfils all other requirements for an Honours degree. The University cannot undertake to notify him (her) that he (she) may be eligible for an Honours degree.*

- b. At the beginning of each registration period the Head(s), or delegate(s), of the Department(s) in which a candidate is taking Honours, shall approve a candidate's program. The Head(s) of Department(s), or delegate(s), shall advise each candidate of programs suitable for his or her particular needs.
- c. Students who have been awarded a Bachelor of Science (General) degree may convert it to a Bachelor of Science (Honours) degree by declaring their intention and by completing the requirements for the Honours degree as outlined in these regulations.
- d. To graduate, a candidate for an Honours degree must have completed all courses listed under **Admission to the Department of Subject of Major** in addition to those courses required by individual departmental regulations.

2. Course Requirements

- a. i. For the Honours Degree of Bachelor of Science with a single subject major a candidate will be required to have completed 120 prescribed credit hours in courses. For the Joint Honours Degree of Bachelor of Science a candidate will be required to have completed either 120 or 135 credit hours as prescribed by the specific program. In either case, those courses must include the courses specified in Clause 1 of the Regulations for the General Degree of Bachelor of Science.
- ii. Clause 2.a. i. notwithstanding, certain Departmental regulations preclude the possibility of completing a single subject Honours degree in 120 credit hours and may require the completion of 123, 126 or 129 credit hours in courses. (See Note below). In such cases all courses required to satisfy requirements of the degree will be used to determine Academic Standing 6. b. below.

Note: *The requirements for an Honours Degree of Bachelor of Science cannot be completed in 120 credit hours if any of the following three statements is true: (i) the student is a major in Chemistry, or Physics and has completed the former Mathematics 1080; (ii) the student is a major in Chemistry or Physics and has completed the former Chemistry 1800; (iii) the student is a candidate for the Honours B.Sc degree in Chemistry or Physics and has completed Physics 1021. Such students will only meet the degree requirements after completing 123, 126 or 129 credit hours in courses.*

- b. Courses shall be chosen so that a candidate shall have completed:

Either, (i) at least 60 credit hours from courses in one of the following subjects, including the courses in that subject completed at the first year level: Biology, Biochemistry, Chemistry, Computer Science (See Note 2.), Earth Sciences, Economics, Geography, Mathematics and Statistics, Physics and Psychology.

- Notes: 1. *For options in the Biochemistry, Dietetics and Nutrition programs the courses shall be those specified in the respective programs.*
 2. *For the Behavioural Neuroscience Program, the courses shall be those specified in the program.*
 3. *For the Environmental Physics Program, the courses shall be those specified in the program.*

or, (ii) at least 84 credit hours in courses from two subjects listed in i. above, including the courses in these subjects completed at the first year level, with no fewer than 36 credit hours in either subject approved by the Committee on Undergraduate Studies of the Faculty of Science on the recommendation of the respective Heads of Departments.

or, (iii) in special circumstances, a program of at least 90 credit hours in courses from two or more subjects, including the courses in these subjects completed at the first year level, one of which need not be taken from those listed in i. above, as recommended by the Heads of the Departments concerned and approved by the Committee on Undergraduate Studies of the Faculty of Science.

- c. Further courses may be chosen from any of the subjects listed in Clause 2. b. above, or from other courses recognized for this purpose by the Committee on Undergraduate Studies of the Faculty of Science (see Note 5 of the Bachelor of Science General Degree) provided that, of the 120 or more credit hours required:
- i. a candidate shall have completed at least 90 credit hours in courses from the subjects listed in Clause 2. b. above, including those completed at the first-year level, and
 - ii. there shall be no fewer than four subjects in which a candidate shall have completed courses. In the case of unspecified transfer credits awarded in a subject area not taught at Memorial University of Newfoundland, any number of such transfer credits in the aggregate shall count as one subject area.
 - iii. Not more than 15 unspecified transfer credit hours in courses awarded from a subject area not taught at Memorial University of Newfoundland shall be used to satisfy the requirements of the degree.

3. Comprehensive Examination and Dissertation

- a. In addition to the regular examinations, a candidate in an Honours program shall pass a general comprehensive examination in his (her) Major subject or subjects. Alternatively, a candidate may be required to submit a dissertation, which at the discretion of

the Head(s) of the Department(s) of specialization may be followed by an oral examination thereon.

- b. If a candidate is required to submit a dissertation, such dissertation must be submitted to the University Library before the degree is conferred. All Honours dissertations in the University Library shall be available for unrestricted consultation by students and faculty except under very exceptional circumstances which must be approved by the Committee on Undergraduate Studies. Copyright remains with the author. A signed release form must accompany an essay or a dissertation when it is submitted to the University Library.
- c. The deadline for the submission of Honours dissertations shall be no later than three weeks before the end of the final semester of the candidate's program.
- d. The Honours dissertation shall be equivalent to either a 3 credit hour course or a 6 credit hour linked course as specified in the course offerings of each Department.

4. Departmental Regulations

Candidates for Honours Degrees shall also comply with such additional requirements of the appropriate Department(s) as are approved by the Senate and printed in the Calendar.

5. Residence Requirements

- a. To qualify for an Honours Degree in Science, a candidate shall attend a recognized university or an equivalent institution for at least seven semesters as a full-time student. Honours candidates transferring credits to Memorial University of Newfoundland from other universities or equivalent institutions shall either spend a minimum of four of the seven semesters as full-time students at Memorial University of Newfoundland, and take a minimum of 24 credit hours in courses from their Honours discipline or take a minimum of 36 credit hours in courses from their Honours discipline as full-time students at Memorial University of Newfoundland (whichever is to their advantage), provided that the total number of semesters spent as full-time students at this and other recognized universities or equivalent institutions will not be less than seven.
- b. To qualify for an Honours Degree in Science and additionally a second degree, a candidate shall attend this University for at least ten semesters as a full-time student, except with the special permission of the Faculty Committee on Undergraduate Studies.

6. Academic Standing

In order to graduate with an Honours degree, a candidate shall obtain:

- a. a grade of "B" or better, OR an average of 75% or higher (whichever is to the candidate's advantage) in the minimum number of courses in the Honours subject (or subjects) prescribed by the Department (or, in the case of joint Honours, Departments) concerned, excluding the 1000-level courses,

AND

- b. an average of at least 2.75 points on the total number of courses required for the degree (see **UNIVERSITY REGULATIONS - General Academic Regulations (Undergraduate), Grading** for explanation of the point system).

Note: A student may, with the approval of the Head of the Department and the Committee on Undergraduate Studies, repeat or substitute up to three courses in order to meet the requirements of Clause 6.a. above. In counting repeats, each attempt at the same course will count as one course towards the maximum. That is, the same course, repeated three times, would place a student at the maximum and no additional repeats or substitutions would be allowed.

7. Classification of Degrees

- a. If the candidate's general average is 3.25 or better per required course, and his (her) average for the courses in his (her) Honours subject (excluding 1000-level courses) is 3.50 or better, he (she) shall be awarded an Honours degree with First Class standing.
- b. If the candidate fulfils the conditions of Clause 6. but not of Clause 7 a., he (she) shall be awarded an Honours degree with Second Class standing.
- c. No classification will be given to the degree awarded a candidate who has completed (i) fewer than one half of the courses required for the degree at this University, or (ii) who has completed fewer than one half of the courses required for the degree at this University since 1959. All candidates for such degrees shall, however, fulfil the conditions of Clause 6. on the courses taken at the University since September, 1959, in order to qualify for the degree.
- d. A declared candidate for an Honours degree who fails to attain the academic standing specified in Clause 6. but fulfills the academic requirements for a General Degree shall be awarded a General Degree, the classification of which shall be determined in accordance with the **UNIVERSITY REGULATIONS - General Academic Regulations (Undergraduate), Graduation**.

3 Joint Programs

The following joint programs are offered by Departments in the Faculty of Science, and the regulations for each program are joint Departmental Regulations.

Note: for convenience of reference the joint programs are listed below in alphabetical sequence.

1. Joint Honours
2. Joint Majors
3. Joint Options

3.1 Biochemistry (Nutrition)/Psychology (Behavioural Neuroscience) Joint Honours

The following courses (or equivalents) are required:

1. Chemistry 1010 and 1011 (or 1050, 1051), Biology 1001 and 1002, Mathematics 1000, Physics 1020 or 1050, and 1021 (or 1051), English 1080 and 1110.
2. Biochemistry 2100, 2101, 3106, 3200, 3201, 3202, 4002, 4300, 4301, 4502, Medicine 310A/B.
3. Psychology 1000, 1001, 2520, 2570, 2910, 2911, 3800, 3801, 3900; two further courses in Psychology chosen from the following: 3050, 3100, 3250, 3350, 3450, 3620, 3650, 3750; two 4000 level courses in Psychology of which one must be a research experience course.
4. Either Biochemistry 499A/B or Psychology 499A/B.
5. Chemistry 2400, 2401 or Chemistry 2440.
6. Other courses to complete at least the prescribed minimum of 120 credit hours in courses for the Joint Honours Degree.

- Notes: 1. *In accordance with Clause 6.a. of the Regulations for the Honours Degree of Bachelor of Science, Honours candidates must obtain a grade of "B" or better, or an average of 75% or higher in all the required courses listed in Clauses 2., 3., and 4. above, except those at the 1000 level.*
2. *Students in first year intending to follow this program should note the regulations as outlined for admission to Major programs in Psychology and that the deadline for submission of a completed application form to the Psychology Department is June 1 for the Fall semester and October 1 for the Winter semester.*

3.2 Biochemistry/Psychology (Behavioural Neuroscience) Joint Honours

The following courses (or equivalents) are required to complete the 120 credit hours in courses required for the degree:

1. Chemistry 1050 and 1051 (or equivalents), Biology 1001 and 1002, Mathematics 1000 and 1001, Physics 1050 or 1020, and 1051, English 1080 and 1110.
2. Biochemistry 2100, 2101, 3105, 3106, 3107, 3108, Medicine 310A/B, either 4210 or 4211, 9 credit hours chosen from Biochemistry 4002, 4101, 4102, 4103, 4104, 4105, 4200, 4201, 4220.
Note: *Only one of 4105 and 4220 may be chosen.*
3. Psychology 1000, 1001, 2520, 2570, 2910, 2911, 3800, 3801, 3900, two further courses in Psychology chosen from the following: 3050, 3100, 3250, 3350, 3450, 3620, 3650, 3750; two 4000 level courses in Psychology of which one must be a research experience course.
4. Either Biochemistry 499A/B or Psychology 499A/B.
5. Chemistry 2300, 2400, 2401.

- Notes: 1. *In accordance with Clause 6. a. of the Regulations for the Honours Degree of Bachelor of Science, Honours candidates must obtain a grade of "B" or better, or an average of 75% or higher in all the required courses listed in Clauses 2., 3. and 4. above, except those at the 1000 level.*
2. *Students in first year intending to follow this program should note the regulations for admission to Major programs in Psychology and that the deadline for submission of a completed application form to the Psychology Department is June 1 for the Fall semester and October 1 for the Winter semester.*

3.3 Physics/Biochemistry Joint Honours

The following courses are prescribed:

1. English 1080 and 1110 (or equivalent), Chemistry 1050 and 1051 (or Chemistry 1010, 1011, and 1031), Mathematics 1000 and 1001, Physics 1050 and 1051 (or 1020, 1021 and 1051).
2. Chemistry 2400, 2401.
3. Chemistry 2300 or Physics 2053
4. Mathematics 2000, 2050, Applied Mathematics/Pure Mathematics 3260, either Applied Mathematics/Pure Mathematics 3202 or Physics 3810.
5. Biochemistry 2100, 2101, 3105, 3106, 3107, 3108, Medicine 310A/B; plus 9 credit hours in courses to be selected from Biochemistry 4002, 4101, 4102, 4103, 4104, 4200 and 4201; plus a 3 credit hour course to be selected from Biochemistry 4210 or 4211.
6. Physics 2055, 2750 or 2056, 2820, 3220, 3400, 3500, 3750, 3820, 3821, 3900, plus one 4000 level Physics course.
7. One course to be selected from Physics 3150, 3300, 3410, 3751. Physics 3751 is recommended.
8. Either Physics 490A/B or Biochemistry 499A/B.
9. Other courses to complete the prescribed minimum of 135 credit hours in courses for the Joint Honours degree.

3.4 Chemistry/Biochemistry Joint Honours Degree

The following courses (or their equivalents) are required:

1. Chemistry 1050 and 1051 (or Chemistry 1010, 1011 and 1031) or their equivalents, Mathematics 1000 and 1001, Physics 1050 and 1051, 6 credit hours in first year English courses. Biology 1001 and 1002 are highly recommended.
2. Mathematics 2000, 2050, Applied Mathematics/Pure Mathematics 3260.
3. Chemistry 2210, 2300, 2400, 2401, 3100, 3211, 3300, 3301, 3410, 3411, 3500; 4110; and 6 further credit hours in Chemistry courses at the 4000 level.
4. Biochemistry 2100, 2101, 3105, 3106, 3107, 3108, Medicine 310A/B, either Biochemistry 4210 or 4211, 9 credit hours chosen from Biochemistry 4002, 4101, 4102, 4103, 4104, 4105, 4200, 4201, 4220.
Note: *Only one of 4105, 4220 may be chosen.*
5. Either Chemistry 490A/B or Biochemistry 499A/B.
6. Other courses to complete the prescribed minimum of 135 credit hours in courses for the Joint Honours Degree. Physics 2820 and/or Physics 2750 are recommended.

3.5 Cell Biology and Biochemistry Joint Honours

Students must have at least an overall average of 65% in English 1080 and 1110 (or equivalents), Mathematics 1000 and 1001, Biology 1001 and 1002, Chemistry 1050 and 1051 (or equivalents), Physics 1050 and 1051 (or 1020, 1021 and 1051).

The following courses, including prerequisites where applicable, will be required.

1. Biochemistry 2101, 3105, 3106, 3107, 3108, either 4210 or 4211, 12 credit hours chosen from 4002, 4101, 4102, 4103, 4104, 4105, 4200, 4201.
2. Biology 2060, 2250, 2600, 2900, 3050 and 9 credit hours chosen from 3500, 3530, 3620, 4000, 4200, 4241. In addition, further Biology courses must be selected by the student to make up a minimum of 42 credit hours in Biology including Biology 1001 and 1002 but not including Biology 499A or 499B.
3. Either Medicine 310A/B, or Biology 3401 plus one of Biology 3402, 4245 or 4404.
4. Chemistry 2300, 2400, 2401, 3100; either 3410 or 3411.
5. Statistics 2550 or equivalent.
6. An Honours Dissertation (Biology 499A/499B or Biochemistry 499A/499B).
7. Other courses to complete the prescribed minimum of 135 credit hours in courses for the Joint Honours Degree.

Note: *Students may count only one of the two courses, Biochemistry 4105 or Biology 4200, for credit in this program.*

The topic of the Honours dissertation must be chosen with the approval of both Departments. A faculty member of either Department may act as supervisor.

Seventy-eight credit hours in Biology, Biochemistry and Chemistry courses beyond the first-year level from those listed in the program shall contribute to those in which a grade of "B" or an average of 75 or higher is required. Medicine 310A/B counts as Biochemistry for these seventy-eight credit hours.

3.6 Biology and Earth Sciences Joint Honours

The following courses, including prerequisites where applicable, will be required:

1. English 1080 and 1110 (or equivalents), Mathematics 1000 and 1001, Biology 1001 and 1002, Earth Sciences 1000 and 1002, Chemistry 1010 and 1011 (or 1050 and 1051), Physics 1020 and 1021 (or 1050 and 1051).
2. Chemistry 2440, Biochemistry 2101, Biochemistry 3106, one of Statistics 2550, 2560 or 2510.
3. Biology 2060, 2250, 2600, 2900, one of 3401, 3402, 4245 or 4404; plus Biology 3710, 3711, and 4505. In addition, further Biology courses must be selected by the student in consultation with the supervisor to make up a minimum of 42 credit hours in Biology not including Biology 499A or 499B.
4. Earth Sciences 2030, 2031, 2502, 2905; plus a minimum of 24 credit hours in other Earth Science courses from 2000 to 4000 level, at least 3 credit hours of which must be at 4000 level. Earth Sciences 2150, 2914, 2915, 2916, and 4310 cannot be used to fulfill this requirement. Career-related streams outlined in the departmental Student Handbook should be used as a guide to course selection so as to achieve a concentration in one facet of Earth Sciences.
5. An Honours dissertation (Biology 499A/B or Earth Sciences 499A/B). The topic of the Honours dissertation must be chosen with the approval of both Department Heads. A faculty member of either Department may act as supervisor.
6. Other courses to complete the prescribed minimum of 135 credit hours in courses for the Honours degree, with at least 84 credit hours in courses in Biology and Earth Sciences combined.

Any change in the program of study must have the prior approval of the Heads of the two Departments concerned.

3.7 Biology/Psychology Joint Honours

The following forty courses (or equivalent) are required:

1. Biology 1001, 1002, 2060, 2250, 2600, 2900; one of 3401, 3402, 4245, 4404; four Biology electives not including Biology 499A or 499B.
2. Psychology 1000, 1001, 2520, 2570, 2910, 2911, 3250, 3800 or 3801; 3900, 4910; one of the following: 3050, 3100, 3350, 3450, 3620, 3650; one further 4000 level Psychology research experience course.
3. Biology or Psychology 3750, 4701, 499A/B.
4. English 1080 and 1110; Mathematics 1000; Chemistry 1010 and 1011 (or 1050 and 1051), and 2440; Physics 1020 (or 1050) and 1021 (or 1051); Biochemistry 2101 and 3106.
5. Other courses, if necessary, to complete at least 120 credit hours of courses.

3.8 Biology/Psychology (Behavioural Neuroscience) Joint Honours

The following forty courses (or equivalents) are required:

1. Biology 1001, 1002, 2060, 2250, 2600, 2900; one of 3401, 3402, 4245, 4404; five Biology electives not including Biology 499A or 499B.
2. Psychology 1000, 1001, 2520, 2570, 2910, 2911, 3800, 3801, 3900; two further courses in Psychology chosen from the following: 3050, 3100, 3250, 3350, 3450, 3620, 3650, 3750; two 4000 level courses in Psychology of which one must be a research experience course.
3. Biology or Psychology 499A/B.
4. Biochemistry 2101, 3106.
5. English 1080 and 1110; Mathematics 1000 and 1001; Physics 1020 or (1050) and 1021 or (1051); Chemistry 1010 and 1011 (or 1050 and 1051), and 2440 (or 2400 and 2401);
6. Other courses, if necessary, to complete at least 120 credit hours of courses.

Note: *In accordance with Clause 6.a. of the Regulations for the Honours Degree of Bachelor of Science, Honours candidates must obtain a grade of "B" or better, OR average of 75% or higher in all the required courses listed in Clauses 1, 2, 3, and 4 above, except those at the 1000 level.*

3.9 Statistics/Biology Joint Honours (B.Sc. Only)

See General Regulations for Honours Degree. Students shall complete the following requirements:

1. Mathematics 1000 and Mathematics 1001, Biology 1001 and 1002, English 1080 and 1110, Chemistry 1010 and 1011 (or 1050 and 1051), Physics 1020 and 1021, or equivalents;
2. Mathematics 2000, 2050, 2051, Statistics 2500 or 2510, 2501 or 2560 or 2511, 3520, 3521, 3530, and 4581;
3. nine further credit hours in Statistics courses (excluding those with second digit 0) including at least 6 credit hours in courses at the 4000 level or higher but not including Statistics 4599;
4. Chemistry 2440 (or 2400 and 2401). Biochemistry 2101 and 3106. Computer Science 2602;
5. Biology 2060, 2250, 2600, 2900, one of 3401, 3402, 4245, or 4404. In addition, further Biology courses must be selected by the student in consultation with the supervisor to make up a minimum of 42 credit hours in Biology but not including Biology 499A or 499B.
6. Either Biology 499A/B or Statistics 4599.

3.10 Joint Honours in Computer Science and Geography (B.Sc. Only)

1. Computer Science Requirements

See General Regulations for the Honours Degree.

Forty-eight credit hours in Computer Science courses are required for the Joint Honours:

- a. 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3754, 4751 and 4770.

- b. Six additional credit hours in courses at the 4000 level not including 4780.
- c. Three additional credit hours in courses at the 3000 level or beyond.

2. Geography Requirements

Forty-eight credit hours in Geography courses are required for the Joint Honours: 1050, 2001, 2102, 2195, 2226, 2302, 2425, 3202, 3222, 3226, 3250, 3260, 3303, 4202, 4250, 4261, and 4291.

3. Additional Requirements

- a. Mathematics 2000, 2050, and Pure Mathematics 2320.
- b. An Honours Dissertation (either Computer Science 4780 or Geography 4999). The topic for dissertation must be chosen with the prior approval of the Heads of both Departments.

3.11 Joint Honours in Computer Science and Physics

The following courses are prescribed:

1. Chemistry 1050 and 1051 (or Chemistry 1010, 1011, and 1031).
2. a. Computer Science 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3731, 3754 and 4770.
b. Nine additional credit hours in Computer Science courses numbered 3000 or higher, including at least 6 credit hours in courses numbered 4000 or higher.
3. a. Physics 1050 and 1051, or Physics 1020, 1021 and 1051.
b. Physics 2053, 2055, 2750 or 2056, 2820, 3220, 3400, 3500, 3750, 3820, 3821, 4500, and 3230 or 3900.
4. Physics 490A/B or Computer Science 4780.
5. Physics 3810 or Applied Mathematics/Pure Mathematics 3202.
6. a. Mathematics 1000 and 1001.
b. Mathematics 2000, 2050, Pure Mathematics 2320 and Applied Mathematics/Pure Mathematics 3260

Statistics 2510 is recommended.

The topic for the Honours project or thesis, Computer Science 4780 or Physics 490A/B, must be chosen with the prior approval of both Departments.

3.12 Joint Honours in Geography/Earth Sciences (B.Sc. Only)

The following courses will be required. A few prerequisites are not met by this list of courses, and students are advised to obtain advice from instructors in such cases to be sure that they are prepared for course material. Both departmental Heads can advise students on a workable sequencing of courses to complete the degree in a timely manner.

1. Six credit hours in first-year English courses; Geography 1050; Earth Sciences 1000 and 1002; Mathematics 1000 and 1001; Chemistry 1010 and 1011 or equivalent; Physics 1050 and (1051 or the former 1054) OR Physics 1020 and 1021.
2. One of Geography 3222, Statistics 2500, 2510.
3. Biology 2120 or Biology 1001 and 1002.
4. Geography 2102, 2195, 2302, 2425, 3230.
5. Earth Sciences 2030, 2031, 2502 and 2905.
6. Either Earth Sciences 499A and 499B, or Geography 4990 and 4999.
7. Twenty-one additional credit hours in Geography courses, of which at least 12 credit hours must be selected from the group Geography 2200, 3110, 3120, 3140, 3150, 3250, 3425, and of which at least 6 credit hours must be in courses at the 4000 level.
8. Twenty-one additional credit hours in Earth Sciences courses, of which at least 9 credit hours must be in courses at 3000 level and at least 6 credit hours must be in courses at 4000 level. Earth Sciences 2150, 2914, 2915, 2916 and 4310 cannot be used to fulfill this requirement.
9. Other courses to complete the prescribed minimum of 120 credit hours.

The topic of the Honours dissertation must be chosen with the approval of both Departments. A faculty member of either Department may act as supervisor.

Any change in the program of study must have the prior approval of the Heads of the two Departments concerned.

3.13 Statistics/Computer Science Joint Honours (B.Sc. Only)

See General Regulations for Honours Degree. In addition to Mathematics 1000 and 1001 the following courses numbered 2000 or higher are required:

1. Mathematics 2000, 2050, 2051, Pure Mathematics 2320, 3340, Pure Mathematics/Statistics 3410, 3411, Statistics 3520, 3521, 3530, 3540, and 4590;
2. Twenty-four further credit hours in Statistics courses (excluding those with second digit 0) including at least 12 credit hours in courses numbered 4000 or higher, but not including Statistics 4599 and 4581;
3. Computer Science 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3754, 4734, and 4770.
4. Six additional credit hours in Computer Science courses at the 4000 level, not including 4780.
5. Either Computer Science 4780 or Statistics 4599.

3.14 Earth Sciences/Chemistry Joint Honours

The following courses, including prerequisites, where applicable, will be required:

1. English 1080 and 1110 (or equivalents), Mathematics 1000 and 1001, Earth Sciences 1000 and 1002, Chemistry 1050 and 1051 (or 1010, 1011 and 1031) or their equivalents, Physics 1050 (or 1020 and 1021) and 1051.
2. Earth Sciences 2030, 2031, 2400, 2401, 2502, 2905, 3600, 3701 (or 2702), 4901; one of 3053, 3054 or 3055; at least one of Earth Sciences 3210 or 3811; plus 6 additional credit hours in Earth Sciences courses.
3. Chemistry 2210, 2300, 2400, 2401, 3100, 3211, 3300, 3301, 3410, 3411, 3500, and at least 3 credit hours in Chemistry courses at the 4000 level.

4. Mathematics 2000, 2050, Applied Mathematics/Pure Mathematics 3260.
5. Physics 2820.
6. Biology 2120 (or Biology 1001 and 1002).
7. An Honours Dissertation (Earth Sciences 499A/B or Chemistry 490A/B). The topic of the Honours Dissertation must have the prior approval of the Heads of the two Departments. A faculty member of either Department may act as supervisor.
8. Other courses to complete the prescribed minimum of 135 credit hours.

Any change in the program of study must have the prior approval of the Heads of the two Departments concerned.

3.15 Joint Honours in Earth Sciences/Physics

This program was formerly in the Earth Sciences section of the calendar as an Honours B.Sc. Degree in Geophysics. The following courses will be required:

1. English 1080 and 1110 (or equivalents), Mathematics 1000 and 1001, Earth Sciences 1000 and 1002, Chemistry 1010 and 1011 (or equivalent), Physics 1050 and 1051 (or Physics 1020, 1021 and 1051).
2. Earth Sciences 2030, 2031, 2400, 2401, 2502, 2905, 3170, 3172, 4105, 4171, 4173, 4179, 499A/B.
3. Physics 2055, 2750 or 2056, 2820, 3220, 3230, 3500, 3820, 3821; plus 9 other credit hours in Physics courses at 3000 level or higher.
4. One of Physics 3810 or Applied Mathematics/Pure Mathematics 3202.
5. Mathematics 2000, 2050, and 3260.
6. Other courses to complete at least a minimum of 120 credit hours.

Any change in the program of study must have the prior approval of the Heads of the two Departments concerned.

3.16 Joint Honours in Geophysics and Physical Oceanography

The program requires the following courses:

1. English 1080 and 1110 (or equivalent), Chemistry 1050 and 1051 (or Chemistry 1010, 1011, and 1031), Mathematics 1000 and 1001, Earth Sciences 1000 and 1002, Physics 1050 and 1051 (or Physics 1020, 1021 and 1051).
2. Earth Sciences 2905, 3170, 3172, 4105, 4171, 4173, 4179 and 10 credit hours at the 2000 level or higher with at least 3 credit hours at the 3000 level.
3. Physics 2053, 2055, 2820, 3220, 3300, 3500, 3820, 3821, 4205, 4300, 4330 plus one of Physics 3600, 3150, 3400, 3550 or 3900.
4. Mathematics 2000, 2050, 2051, 3202 and 3260.
5. Either Earth Sciences 499A and 499B or Physics 490A and 490B.
6. Other courses to complete the prescribed minimum of 120 credit hours.

3.17 Applied Mathematics/Chemistry Joint Honours (B.Sc. Only)

See General Regulations for Honours Degree. In addition, Chemistry 1050 and 1051 (or Chemistry 1010, 1011 and 1031), Mathematics 1000, and 1001, Physics 1050 (or 1020) and 1051, the following courses numbered 2000 or higher are required:

1. Chemistry 2210, 2300, 2400, 2401, 3100, 3211, 3300, 3301, 3500, 4300, 4302, and a 3 credit hour Chemistry elective.
2. Mathematics 2000, 2050, 2051, 3000, 3001, Applied Mathematics 2130, 3132, 3161, Applied Mathematics/Pure Mathematics 3202, 3210, 3260, and Applied Mathematics 4160.
3. Physics 2055, 2056 or 2750, 2820, 3220 and 3230.
4. either Applied Mathematics 4199 or Chemistry 490A/B.

The following courses are recommended:

Chemistry 3410, 3411, 4100, Applied Mathematics 3100, 4131, 4132, 4133, Applied Mathematics/Pure Mathematics 3240, Pure Mathematics 3320, Statistics 2510, Physics 3500 and 4500.

3.18 Pure Mathematics/Computer Science Joint Honours (B.Sc. Only)

See General Regulations for Honours Degree. Students shall complete the following:

At least 51 credit hours in Computer Science courses are required including the following:

1. 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3754, and 4770.
2. Excluding 4780, 15 additional credit hours from courses numbered 3000 or higher, at least 9 credit hours of which must be in courses at the 4000 level.

The following courses in Mathematics and Statistics are required:

1. Mathematics 1000, 1001, 2000, 2050, 2051, Applied Mathematics 2130, Pure Mathematics 2320, Mathematics 3000, 3001, Applied Mathematics/Pure Mathematics 3202, 3210, 3260, Pure Mathematics 3301, 3320, 3340, Statistics 2510;
2. Excluding Pure Mathematics 4399, 15 additional credit hours in courses offered by the Department of Mathematics and Statistics numbered 3000 or higher including at least 9 credit hours from courses numbered 4000 or higher and at least 9 credit hours in Pure Mathematics courses;
3. An Honours Dissertation in one of the departments, with the topic chosen in consultation with both departments.

Note: *There is an Undergraduate Advisor in each Department. These advisors should be consulted on all academic matters.*

3.19 Pure Mathematics/Statistics Joint Honours

See General Regulations for Honours Degree. In addition to Mathematics 1000 and 1001 the following courses numbered 2000 or higher are required:

1. Mathematics 2000, 2050, 2051, 3000, 3001, Applied Mathematics 2130, Pure Mathematics 2320, Applied Mathematics/Pure Mathematics 3202, 3210, 3260, Pure Mathematics/Statistics 3410, 3411, Statistics 3520, 3521, 3530, Pure Mathematics/Statistics 4400, 4401, 4410;
2. A computing course early in the program is required. Computer Science 1510 is highly recommended;

- either Pure Mathematics 4399 or Statistics 4599;
- one of: Pure Mathematics 3301, 3330, or 3340;
- Twenty-one further credit hours in Pure Mathematics and/or Statistics courses numbered 3000 or higher of which at least 12 credit hours must be from courses numbered 4000 or higher excluding Statistics 4581.

3.20 Applied Mathematics/Physics Joint Honours

The following courses are required:

- English 1080 and English 1110 (or equivalent).
- A computing course. Computer Science 1510 is recommended.
- Six credit hours in a science other than Mathematics or Physics (if Computer Science is chosen then Computer Science 1510 may be counted as three of these hours).
- Mathematics 1000, 1001, 2000, 2050, 2051, 3000, 3001, Applied Mathematics/Pure Mathematics 3202, 3210, 3260, Applied Mathematics 3132.
- At least one of Applied Mathematics 2130 or Pure Mathematics 2320.
- Physics 1050 (or 1020), 1051, 2053, 2055, 2750 (or 2056), 2820, 3220, 3230, 3400, 3500, 3750.
- Three additional credit hours chosen from courses numbered 3000 or higher that are offered by the Department of Physics and Physical Oceanography.
- Applied Mathematics 3161 and Applied Mathematics 4160, or Physics 3820 and Physics 3821.
- Physics 490A/B, or Applied Mathematics 4199 plus another 3 credit hour Applied Mathematics course numbered 4000 or higher.
- Twelve additional credit hours chosen from courses numbered 4000 or higher that are offered by the Department of Mathematics and Statistics or the Department of Physics and Physical Oceanography. At least 3 credit hours must be selected in each of Applied Mathematics and Physics.
- A sufficient number of elective courses to bring the degree to a total of 120 credit hours.

The topic for the Honours project or thesis, Applied Mathematics 4199 or Physics 490A/B must be chosen with the prior approval of both departments.

3.21 Physics/Chemistry Joint Honours

The following courses are prescribed:

- Mathematics 2000, 2050, and Applied Mathematics/Pure Mathematics 3260.
- Physics 1050 (or 1020 and 1021) and 1051.
- A minimum of 45 additional credit hours in Physics courses, which shall include 2055, 2750 or 2056, 2820, 3220, 3230, 3500, 3750, 3820, 3821, 3900, and 3 credit hours in a Physics course numbered 3000 or higher and 12 credit hours in Physics courses numbered 4000 or higher.
- Physics 3810 or Applied Mathematics/Pure Mathematics 3202.
- Chemistry 1050 and 1051 (or Chemistry 1010, 1011 and 1031), 2210, 2300, 2400, 2401 and 30 credit hours in Chemistry courses numbered 3000 or higher including 3100, 3211, 3300, 3301, 3500, 4300 and 4302.
- The courses selected in accordance with 3. and 5. above shall include Chemistry 490A/B or Physics 490A/B.

The topic for the Honours thesis, Chemistry 490A/B or Physics 490A/B, must be chosen with the prior approval of both Departments.

3.22 Joint Major in Computer Science and Economics (B.Sc. Only)

1. Computer Science Requirements

Forty-two credit hours in Computer Science courses are required: 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3731, 3753, 3754, and 4770.

2. Economics requirements

A total of 42 credit hours in Economics courses are required: 2010, 2020, 2550, 3000, 3001, 3010, and 6 credit hours from either 3550 and 3551, or 4550 and 4551 are obligatory.

The remaining 18 credit hours shall be chosen from among the various Economics courses in consultation with the Head of the Department or delegate, and will include at least 9 credit hours in courses at the 4000 level.

3. Additional Requirements: Mathematics 1000, 1001, 2000, 2050, Pure Mathematics 2320, and Statistics 2510

3.23 Joint Major in Computer Science and Geography (B.Sc. Only)

1. Computer Science Requirements

Thirty-nine credit hours in Computer Science courses are required: 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3754, 4751, and 4770.

2. Geography Requirements

Thirty-nine credit hours in Geography courses are required: 1050, 2001, 2102, 2195, 2302, 2425, 3202, 3222, 3250, 3260, 4202, 4250, 4261.

3. Additional Requirements: Mathematics 2000, 2050, and Pure Mathematics 2320.

3.24 Applied Mathematics/Computer Science Joint Major (B.Sc. Only)

The following courses are required

- Computer Science 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3754, 4770, plus 6 further credit hours in Computer Science courses numbered 3000 or higher.
- Mathematics 1000, 1001, 2000, 2050, 2051, 3000, Applied Mathematics 2130, Pure Mathematics 2320, Applied Mathematics 3100, 3132, 3161, Applied Mathematics/Pure Mathematics 3202, 3260, Applied Mathematics 4160, 4190, plus one of Applied Mathematics/Pure Mathematics 3210, Applied Mathematics 4131, 4132, 4162

In addition, Statistics 2510 is highly recommended.

3.25 Joint Major in Pure Mathematics and Economics (B.Sc. Only)

1. Mathematics 1000, 1001, 2000, 2050, 3000, Applied Mathematics 2130, 3100, Pure Mathematics 2320, Applied Mathematics/Pure Mathematics 3202, 3260, Pure Mathematics 3320, Statistics 2510 and one 4000 level course.
2. A computing course early in the program is required. Computer Science 1510 is highly recommended.
3. Economics: 2010, 2020, 2550, 3000, 3001, 3010, and 6 credit hours from either 3550 and 3551, or 4550 and 4551.
4. Eighteen further credit hours chosen from among the various Economics courses in consultation with the Head of the Department or delegate, including at least 9 credit hours at the 4000 level.

3.26 Statistics/Computer Science Joint Major (B.Sc. Only)

In addition to Mathematics 1000, 1001, and Computer Science 1710, the following courses numbered 2000 or higher are required:

1. 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3754, 4734, and 4770.
2. Statistics 2510 and 2560.
3. Mathematics 2000, 2050, 2051, Pure Mathematics 2320, 3340, Pure Mathematics/Statistics 3410, 3411, Statistics 3520, 3521, 3540, and 4590.
4. nine further credit hours in Statistics courses numbered 3000 or higher including at least a 3 credit hour course numbered 4000 or higher excluding Statistics 4581.

3.27 Joint Major in Applied Mathematics and Economics (B.Sc. Only)

1. Mathematics 1000, 1001, 2000, 2050, 2051, 3000, Applied Mathematics 2130, 3100, Statistics 2510, Applied Mathematics/Pure Mathematics 3202, 3260, Applied Mathematics 4132.
2. Either Applied Mathematics 3132 and 4131 or 3161 and 4160.
3. A computing course early in the program is required. Computer Science 1510 is highly recommended.
4. Economics: 2010, 2020, 2550, 3000, 3001, 3010, 4550, 4551.
5. Eighteen further credit hours chosen from among the various Economics courses in consultation with the Head of the Department or delegate, including at least 9 credit hours at the 4000 level.

3.28 Joint Major in Applied Mathematics and Physics (B.Sc. Only)

Required course for this degree are:

1. English 1080 and English 1110 (or equivalent).
2. A computing course. Computer Science 1510 is recommended.
3. Six credit hours in science other than Mathematics or Physics (if Computer Science is chosen then Computer Science 1510 may be counted as 3 of these hours).
4. Mathematics 1000, 1001, 2000, 2050, 2051, 3000, 3001. Applied Mathematics/Pure Mathematics 3202, 3260, Applied Mathematics 3132.
5. At least one of Applied Mathematics 2130 or Pure Mathematics 2320.
6. Physics 1050 (or 1020), 1051, 2053, 2055, 2750 (or 2056), 2820, 3220, 3400, 3500, 3750.
7. Applied Mathematics 3161 or Physics 3820.
8. At least 15 additional credit hours chosen from Applied Mathematics and Physics courses numbered 3000 or above. At least 3 hours are required from Applied Mathematics and 6 hours are required from Physics.
9. A writing course. Any one of Applied Mathematics 2130, Physics 3900, Applied Mathematics 4199, or Physics 490A/B is acceptable.

The last requirement does not have to be met independently of the other regulations. For example, it can be satisfied either by choosing Applied Mathematics 2130 from clause 5. above or choosing Physics 3900 as a 3000+ elective in clause 8. above.

3.29 Joint Major in Computer Science and Physics

1. Chemistry 1050 and 1051 (or Chemistry 1010, 1011, and 1031).
2. Thirty-nine credit hours in Computer Science are required for the Joint Major: 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3731, 3754, and 4770.
3. Physics 1050 and 1051 (or 1020, 1021 and 1051) plus at least 30 additional credit hours in Physics including 2053, 2055, 2750 (or 2056), 2820, 3220, 3400, 3500, 3550, 3750 and 3900.
4.
 - a. Mathematics 1000 and 1001.
 - b. Mathematics 2000 and 2050, Pure Mathematics 2320, Statistics 2510 and Applied Mathematics/Pure Mathematics 3260.
 - c. Physics 3810 or Applied Mathematics/Pure Mathematics 3202.

3.30 Joint Major in Earth Sciences/Physics

This program was formerly in the Earth Sciences section of the calendar as a General B.Sc. Degree in Geophysics. The following courses will be required:

1. English 1080 and 1110 (or equivalents), Mathematics 1000 and 1001, Earth Sciences 1000 and 1002, Chemistry 1010 and 1011 (or equivalent), Physics 1050 and 1051 (or Physics 1020, 1021 and 1051).
2. Earth Sciences 2030, 2031, 2400, 2401, 2502, 2905, 3170, 3172; plus a 3 credit hour course in Earth Sciences 4100 series.
3. at least 30 credit hours in Physics courses at the 2000 level or higher, including Physics 2055, 2056 or 2750, 2820, 3220, 3500.
4. One of Physics 3810 or Applied Mathematics/Pure Mathematics 3202.
5. Mathematics 2000 and 2050.
6. Other courses to complete at least a minimum requirement of 120 credit hours in courses for the General Degree.

Any change in the program of study must have the prior approval of the Heads of the two Departments concerned.

3.31 Joint Major in Statistics and Economics (B.Sc. Only)

1. Mathematics 1000, 1001, 2000, 2050, 2051, Statistics 2510, 2560, Pure Mathematics/Statistics 3410, Pure Mathematics/Statistics 3411, Statistics 3520, 3540, 4590.
2. Six further credit hours in Statistics courses numbered 3000 or higher, at least 3 credit hours of which must be numbered 4000 or higher, excluding Statistics 3521 and 4581.
3. Economics: 2010, 2020, 2550, 3000, 3001, 3010, 4550, 4551.
4. Eighteen further credit hours chosen from among the various Economics courses in consultation with the Head of the Department or delegate, including at least 9 credit hours at the 4000 level.

3.32 Joint Major in Statistics and Economics (Co-operative) (B.Sc. Only)

The Joint Major in Statistics and Economics Co-Operative Education Option is available to full-time Economics and Statistics majors (B. Sc.) only. The program is available under the Economics Co-operative Education Option (ECEO)

The ECEO provides an excellent mutual opportunity for students and employers. Qualified students will obtain rewarding employment experience in fields related to Economics for several months of continuous duration. Students will learn valuable practical skills in an employment situation during their course of study. Furthermore, paid employment will help to defray the cost of their education. The timing of the Work Terms and the structure of the ECEO generally are such that employers stand to gain from the acquired employable skills of economists and statisticians in training. The objectives of the Work Term component of the ECEO are embodied in the Work Term descriptions below. The descriptions serve to guide the student and the employer toward achieving these objectives.

1. Admission Requirements

- a. Admission is competitive and selective. Therefore, prospective students are encouraged to consider an alternate degree program in the event that they are not accepted into the Joint Co-operative program.
- b. Applicants should note that it is possible to enter Term 1 only in the Fall semester commencing in September of each academic year. Application forms are available in the Department of Economics and the Department of Mathematics and Statistics. The deadline for applications for admission to Term 1 is March 1.
- c. The primary criterion used in reaching decisions on applications for admission is overall academic achievement. Students with weak overall academic records are unlikely to be admitted.
- d. To be eligible for admission to Term 1 an applicant must have successfully completed a minimum of 30 credit hours with an overall average of at least 65% as follows: All applicants must have completed Economics 2010 and 2020; at least 6 credit hours in English*; Mathematics 1000 and 1001; and 12 credit hours chosen from courses in the Faculties of Arts or Science.
*It is recommended that students complete English 1110. Critical Reading and Writing II (Context, Substance, Style) as one of these English courses.
- e. Students may apply for admission to Advanced Standing.
- f. Transfer students from other universities will be placed in that term of the program judged to be appropriate considering equivalent credits, as determined by the Departments.

2. Program of Study

- a. Promotion from each of Terms 1 through 6 requires a passing grade in all specified required courses and an overall average of at least 60% in all courses including electives. A student who fails a required course or fails to maintain an overall average of 60% will not be promoted to the next term and will be required to withdraw from the program. The student in question may apply for readmission in a subsequent year after passing the specified required course(s) previously failed, or re-establishing the 60% average.
- b. In addition to the 30 credit hours required for admission, students are required to complete the six academic terms in the ECEO program for a total of 120 credit hours. Students must complete three Work Terms which follow Academic Terms 2, 4, and 5.
- c. Courses shall normally be taken in academic terms or "blocks" in the sequenced course load and order set out in the **Academic Course Program Joint Major (Co-operative) Table**. Unspecified credits may be used to fulfill elective requirements only.
- d. **UNIVERSITY REGULATIONS - General Academic Regulations (Undergraduate) - Classification of Students** notwithstanding, students do not require special permission to register for courses while on work terms if the courses are in addition to the prescribed program.

3. Work Term Placement

See Departmental Regulations in Economics for the Major in Economics (Co-operative), in the Faculty of Arts section of the Calendar.

4. Registration and Evaluation of Performance

See Departmental Regulations in Economics for the Major in Economics (Co-operative), in the Faculty of Arts section of the Calendar.

Academic Course Program - Joint Major in Statistics and Economics (Co-operative) Table

Term 1 (Fall) Economics 3000 Economics 3550 Statistics 2510 Mathematics 2000 Computer Science 1700	Work Term II (Spring) Economics 399W
Term 2 (Winter) Economics 2550 Economics 3001 Economics 3010 Mathematics 2050 Statistics 2560	Term 5 (Fall) Statistics 3520 Statistics 4590 Six further credit hours in Economics courses Three further credit hours in Statistics courses
Work Term I (Spring) Economics 299W	Work Term III (Winter) Economics 499W
Term 3 (Fall) Economics 4550 Mathematics 2051 Statistics 3410 Three further credit hours in Statistics courses Three credit hours in elective courses [see Note 2]	Term 6 (Spring) Three further credit hours in Economics courses Three credit hours in Science courses [see Note 2] Nine credit hours in elective courses [see Note 2]
Term 4 (Winter) Economics 3011 Economics 4120 Economics 4551 Statistics 3411 Statistics 3540	

Notes: 1. Another 1000-level Computer Science course may be substituted for Computer Science 1700 with the Heads' approvals.
2. Elective courses should be chosen with reference to the Regulations for the General Degree of Bachelor of Science, since courses specified for admission to and completion of the program only partially satisfy these regulations. In particular note that in addition to the 78 credit hours (26 courses) in Science subjects required, at least 3 credit hours in a Science subject other than Mathematics/Statistics, Economics and Computer Science must be completed.

3.33 Pure Mathematics/Computer Science Joint Major (B.Sc. Only)

In addition to Mathematics 1000, 1001, and Computer Science 1710, the following courses numbered 2000 or higher are required:

- 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3754, and 4770.
- Six additional credit hours in Computer Science courses numbered 3000 or higher.
- Mathematics 2000, 2050, 2051, Pure Mathematics 2320, Applied Mathematics 2130, Mathematics 3000, Applied Mathematics/Pure Mathematics 3202, Applied Mathematics/Pure Mathematics 3260, Pure Mathematics 3320, 3340, and Statistics 2510.
- Nine additional credit hours in courses numbered 3000 or higher offered by the Department of Mathematics and Statistics.

3.34 Physics/Chemistry Option Programs

Students who follow the five-year Physics/Chemistry Joint Honours Program of courses outlined above either as Honours students or otherwise and who satisfy all relevant course regulations except those on Academic Standing for the Honours Degree of Bachelor of Science shall receive on their University records a notation that they followed the "Physics/Chemistry" Option Programs.

Students who intend to follow a joint degree program are strongly recommended to consult the Head of the Department or delegate at their earliest opportunity to ensure proper planning of their course sequence.

3.35 Joint Degrees of Bachelor of Science (Computer Science) and Bachelor of Commerce (Co-operative)

For students registered in a program leading to the degree of Bachelor of Science majoring in Computer Science who are concurrently completing the Bachelor of Commerce (Co-operative) degree, the number of credit hours required to comply with clause 3. a. of the Degree Regulation for the General Degree of Bachelor of Science will be reduced to 69 credit hours. This adjustment will be permitted only for students who are graduating with the Bachelor of Science degree (majoring in Computer Science) and the Bachelor of Commerce (Co-operative) degree at the same convocation. In order to meet all of the requirements of both degree programs at the same time, students who are completing the joint degrees are strongly advised to follow the **Suggested Program of Studies** outlined below, and to seek advice from the Department of Computer Science and the Faculty of Business Administration in order to ensure that their proposed program is possible within the constraints of course scheduling and prerequisites.

Suggested Program of Studies: Bachelor of Science (Computer Science) and Bachelor of Commerce (Co-operative) Prior to admission to the Bachelor of Commerce (Co-operative) program:

For the joint degrees of Bachelor of Science majoring in Computer Science and Bachelor of Commerce (Co-operative), students must successfully complete a minimum of 150 credit hours in courses applicable to the degrees. To be eligible for admission to Term 1 of the Bachelor of Commerce (Co-operative) program, an applicant must have successfully completed 30 credit hours with an overall average of at least 65% on the courses comprising those credit hours. For the Joint Degree, the 30 credit hours must comprise:

- Six credit hours in English courses;
- Six credit hours in Mathematics courses, which must include Mathematics 1000;
- Economics 2010 and 2020;
- Business 1000;
- Computer Science 1710;

6. Six additional credit hours in Science electives. Following admission to the Joint Program, the curriculum is as set out in the table below.

Please refer to the calendar entry for the Faculty of Business Administration for complete course descriptions, regulations and plan of operation for the Bachelor of Commerce (Co-operative) component of the degree, and to the entry for Computer Science for the Computer Science course descriptions.

Bachelor of Commerce (Co-operative) Curriculum (Completed Jointly with The Degree of Bachelor of Science with a Major in Computer Science) Table

Term One (Fall)	Business 1101 Business 1201 Statistics 2500 or Statistics 2510 Computer Science 2710 Computer Science 2742 Business 1600
Term Two (Winter)	Business 2000 Business 2101 Business 2201 Business 2301 Business 2401 Pure Mathematics 2320
Spring	[see Notes 1 and 2 below]
Term Three (Fall)	Business 3320 Business 3401 Business 3700 Computer Science 2711 Computer Science 2760
Work Term I (Winter)	Business 399W [see Note 1 below]
Term Four (Spring)	Business 4000 Business 4320 Business 4401 Business 4500 Economics 3150
Work Term II (Fall)	Business 499W [see Note 1 below]
Term Five (Winter)	Business 5301 Computer Science 3719 Computer Science 3724 Six credit hours of electives [see Note 3 below]
Work Term III (Spring)	Business 599W [see Note 1 below]
Term Six (Fall)	Business 7000 Computer Science 3715 Computer Science 3716 Computer Science 3725 Three credit hours of electives [see Note 3 below]
Term Seven (Winter)	Computer Science 3754 Computer Science 4770 1 Computer Science elective Six credit hours of electives [see Note 3 below]

- Notes: 1. Students are advised that, in order to complete the joint degrees within the minimum 150 credit hours, they should be prepared to complete at least three of the courses required for the degree of Bachelor of Science as opportunities arise and as courses are offered. Following Term Two of the program for the Bachelor of Commerce (Co-operative) degree, these courses may be completed during the Spring semester between Terms 2 and 3, or during any of the three Work Terms (for example, in the evening or by distance), or during Terms 3, 4, 5, 6 or 7 (following submission of a course-load waiver).
2. To meet the requirements for the Joint Degree in the minimum number of 150 credit hours, careful planning, particularly in the selection of elective courses as well as in the sequence of Major program courses, is recommended to ensure timely completion. Also note that, in order to meet the Science general regulations, students must have completed courses in at least four areas of Science.
3. Six credit hours must be Business electives and 6 credit hours must be Science electives.

4 Waiver of Regulations for Undergraduate Students

Where circumstances warrant, any prerequisite or prerequisites listed in Departmental Regulations may be waived by the Head of the Department. Any Department Regulations may be waived by the appropriate Committee on Undergraduate Studies upon request of the Head of the Department concerned.

5 Program Regulations and Course Descriptions

5.1 Biochemistry

5.1.1 Programs

The following undergraduate programs are available in the Department:

1. Major or Honours in Biochemistry
2. Major or Honours in Nutrition

3. Major or Honours in Dietetics - Admission to this program is under review. For further information see **Important Note** under Professional Program in Dietetics.
4. Joint Honours in Biochemistry and Cell Biology/Microbiology
5. Joint Honours in Biochemistry and Chemistry
6. Joint Honours in Biochemistry and Physics
7. Joint Honours in Biochemistry (Nutrition)/Psychology (Behavioural Neuroscience)
8. Joint Honours in Biochemistry/Psychology (Behavioural Neuroscience)
9. Minor in Biochemistry
10. Minor in Nutrition

Students who wish to enrol in any of these programs should plan their program well in advance so that they will have taken the appropriate prerequisites. Entry to a number of required courses is limited and will be determined by academic performance. Required courses should be taken in the year indicated by the course numbers so as to avoid timetable clashes and missing prerequisites which could prolong the time necessary to complete the program. Students are advised to consult with the Department at the earliest opportunity.

Candidates for the general and honours degrees in the programs above should refer to the **UNIVERSITY REGULATIONS - General Academic Regulations (Undergraduate)** for the **General and Honours degrees of Bachelor of Science**.

Students who intend to pursue graduate studies should take the courses leading to the honours degree.

Note: *Supplementary examinations will be allowed in certain Biochemistry courses which have written final examinations. Students should refer to the Faculty of Science Degree Regulations for details.*

5.1.2 Admission to Programs

Students who wish to declare a Major in Biochemistry or Biochemistry (Nutrition) or who wish to apply for Honours standing in any of our programs are strongly recommended to do so by June 30 in any year. Students who do not declare by this date may not be considered for departmental scholarship or other awards.

Note: *For further information see regulations governing admission to Biochemistry (Dietetics).*

5.1.3 Biochemistry Program

5.1.3.1 Major in Biochemistry

Entry to the Biochemistry Majors program is based on academic standing.

1. To be considered for admission to the program students must have at least 30 credit hours in courses and have successfully completed the following courses (or their equivalents) with a minimum overall average of 60%. In addition, students must be eligible for entry to Chemistry 2400.
 - a. English 1080, 1110 (or equivalent)
 - b. Chemistry 1050, 1051 (or Chemistry 1010, 1011 or 1201, 1001)
 - c. Mathematics 1000, 1001 (or Math 1090, 1000)
 - d. Physics 1050, 1051 (or Physics 1020, 1021), or Biology 1001, 1002
2. Required courses to complete the major:
 - a. Biochemistry 2100, 2101, 3105, 3106, 3107, 3108.
 - b. At least 12 credit hours in courses from Biochemistry 3200, 4002, 4101, 4103, 4104, 4200, 4201.
 - c. Medicine 310A, 310B or 6 credit hours from Biology 2060, 3050, 3401, 3402, 3530, 4200, 4245, 4404, Chemistry 4201
 - d. Biology 1001 and 1002; Mathematics 1001; and Physics 1020 or 1050, and 1051 for those students who did not complete them in first year. Students may also need to complete Physics 1021 in order to fulfil this requirement.
 - e. Chemistry 1031 which is strongly advised to be taken prior to second year for those students who complete Chemistry 1010 and 1011 in first year. see Note 2. below.
 - f. Chemistry 2300, 2400, 2401
 - g. one of Chemistry 3100, Environmental Sciences 3210, Environmental Sciences 3211.

Notes: 1. *Students are required to complete at least 78 credit hours in Science courses for the General Degree.*

2. *Majors who take Chemistry 1010/1011 but not Chemistry 1031 as part of their first year sequence risk waiting a whole year before they can continue taking Biochemistry program courses.*

3. *For the purposes of a Biochemistry degree, Medicine 310A and 310B count as Biochemistry courses.*

3. Students are encouraged to choose a minor.

5.1.3.2 Honours Degree in Biochemistry

Students normally should apply for an Honours program at the completion of their third year of studies. Honours students would normally follow the Biochemistry Majors program before applying to honours, and must meet its admissions requirements as follows:

1. To be considered for admission to the majors program prior to admission to honours, students must have at least 30 credit hours in courses and have successfully completed the following courses (or their equivalents) with a minimum overall average of 60%. In addition, students must be eligible for entry to Chemistry 2400.
 - a. English 1080, 1110 (or equivalent)
 - b. Chemistry 1050, 1051 (or Chemistry 1010, 1011, or 1201, 1001)
 - c. Mathematics 1000, 1001 (or Mathematics 1090, 1000)
 - d. Physics 1050, 1051 (or Physics 1020, 1021) or Biology 1001, 1002
2. To be eligible for admission, students must be in Honours standing. To be considered for early admission to an Honours program in Biochemistry at the end of second year, students must have achieved at least 70% in each of Biochemistry 2100 and 2101 and Chemistry 2400, 2401.
3. Required courses:
 - a. Biochemistry 2100, 2101, 3105, 3106, 3107, 3108, 4102, 499A, 499B, Medicine 310A, 310B.

- b. Biochemistry 4210 or 4211.
- c. Twelve credit hours in courses from Biochemistry 4002, 4101, 4103, 4104, 4200, 4201.
- d. At least 6 credit hours in courses from Biochemistry 3200, 3201, 4105, 4220, Biology 2060, 3050, 3530, 4200, 4245, 4404, Chemistry 4201.
- e. Biology 1001 and 1002; Mathematics 1001; and Physics 1020 or 1050, and 1051 for those students who did not complete them in first year. Students may also need to complete Physics 1021 in order to fulfil this requirement.
- f. Chemistry 1031 which is strongly advised to be taken prior to second year for those students who complete Chemistry 1010 and 1011 in first year (see **Notes** below).
- g. Chemistry 2300, 2400, 2401, one of 3410 or 3411.
- h. One of Chemistry 3100, Chemistry 3500, Environmental Sciences 3210, Environmental Sciences 3211.
- i. Statistics 2550 or equivalent.

Notes: 1. *Majors who take Chemistry 1010/1011 but not Chemistry 1031 as part of their first year sequence risk waiting a whole year before they can continue taking Biochemistry program courses.*

2. *For the purposes of a Honours Degree in Biochemistry, Medicine 310A and 310B count as Biochemistry courses.*

4. Students are encouraged to choose a minor.

Those courses in which a grade "B" or an average of 75% or higher are required, as specified in clause 6. a. of the Regulations for the Honours Degree of Bachelor of Science, are 45 credit hours in Biochemistry courses and 15 credit hours in other courses (beyond the 1000-level) chosen from Biochemistry, Biology, or Chemistry. Biochemistry 2010, 2011, Biology 2040, 2041 and Chemistry 2600, 2601 may not be used to meet this requirement. Medicine 310A/B counts as Biochemistry for these 60 credit hours.

5.1.3.3 Minor in Biochemistry

Students who take a minor in Biochemistry will complete:

1. Biochemistry 2101, 3106
2. Either Biochemistry 2100 or Biology 2250
3. nine credit hours from Biochemistry 3105, 3107, 3108, 4002, 4101, 4103, 4104, 4200, 4201; or 6 credit hours from these Biochemistry courses and 3 credit hours from Chemistry 4201, Biology 2060, 3050.
4. Either Chemistry 2400, 2401 or Chemistry 2440 and 3 additional credit hours from the Biochemistry courses listed in 3. above.

Course prerequisites stipulated in the course descriptions shall apply to a minor in Biochemistry.

5.1.4 Nutrition Program

5.1.4.1 Major in Nutrition

Entry to the Nutrition majors program is based on academic standing.

1. To be considered for admission to the program students must have at least 30 credit hours in courses and have successfully completed the following courses (or their equivalents) with a minimum overall average of 60%.
 - a. English 1080, 1110 (or equivalent)
 - b. Chemistry 1050, 1051 (or Chemistry 1010, 1011 or 1201, 1001)
 - c. Mathematics 1090, 1000 (or Mathematics 1000 and one elective)
 - d. Biology 1001, 1002 or Physics 1020, 1021 (or equivalent)
2. Required courses to complete the major:
 - a. Biochemistry 2000, 2100, 2101, 3106, 3200, 3201, 3202, 3402, 4300, 4301, Medicine 310A, 310B
 - b. One of Biochemistry 3107, 3108, 4002
 - c. Biology 1001 and 1002; and Physics 1020 and 1021 (or equivalent), for those students who did not complete them in first year
 - d. Chemistry 2440 (or Chemistry 2400, 2401)
 - e. Statistics 2550 or equivalent
3. Students are encouraged to choose a minor.

Notes: 1. *Students are required to complete at least 78 credit hours in Science courses for the General Degree.*

2. *Students who choose to complete Chemistry 2400/2401 are advised to take the appropriate prerequisites for those courses.*

3. *For the purposes of a Biochemistry (Nutrition) degree, Medicine 310A and 310B count as Biochemistry courses.*

5.1.4.2 Honours Degree in Nutrition

Students normally should apply for an Honours program at the completion of their third year of studies. Honours students would normally follow the Biochemistry (Nutrition) Majors program before applying to honours, and must meet its admissions requirements as follows:

1. To be considered for admission to the majors program prior to admission to honours, students must have at least 30 credit hours in courses and have successfully completed the following courses (or their equivalents) with a minimum overall average of 60%:
 - a. English 1080, 1110 (or equivalent)
 - b. Chemistry 1050, 1051 (or Chemistry 1010, 1011, or 1201, 1001)
 - c. Mathematics 1090, 1000 (or Mathematics 1000 and one elective)
 - d. Biology 1001, 1002 or Physics 1020, 1021 (or equivalent)
2. To be eligible for admission to the honours program, students must be in Honours standing. To be considered for early admission to an Honours program in Nutrition at the end of second year, students must have achieved at least 70% in each of their required 2000 level Biochemistry and Chemistry courses.
3. Required courses:
 - a. Biochemistry 2000, 2100, 2101, 3106, 3107, 3200, 3201, 3202, 3402, 4002, 4300, 4301, 4502, Medicine 310A, 310B.
 - b. Nine additional credit hours chosen from Biochemistry 3105, 3108, 4101, 4103, 4104, 4105, 4200, 4201, 4210, 4211, 4220, 4400, Biology 3050.
 - c. Either Biochemistry 499A/B or 4999 plus an additional 3 credit hours 4000 level Biochemistry course.

- d. Biology 1001 and 1002; and Physics 1020 and 1021 (or equivalent), for those students who did not complete them in first year.
 - e. Chemistry 2440 (or Chemistry 2400, 2401).
 - f. Statistics 2550 or equivalent.
4. Students are encouraged to choose a minor.
5. Those courses in which the grades specified in clause 6.a. of the Regulations for the Honours Degree of Bachelor of Science are 60 credit hours chosen from Biochemistry courses and Biology 3050.

Notes: 1. *Students who choose to complete Chemistry 2400/2401 are advised to take the appropriate prerequisites for those courses.*
 2. *For the purposes of a Biochemistry (Nutrition) Honours degree, Medicine 310A and 310B count as Biochemistry courses.*

5.1.4.3 Minor in Nutrition

Students who take a minor in Nutrition will complete:

- 1. Biochemistry 2101, 3106, 3200, 3201, Medicine 310A, 310B.
- 2. Six credit hours chosen from Biochemistry 3202, 4300, 4301.

Course prerequisites stipulated in the course descriptions shall apply to a minor in Nutrition. In particular, students should note that one of Chemistry 2440 or Chemistry 2401 are required as co-requisites or prerequisites to several courses.

5.1.5 Professional Program in Dietetics

For professional qualification as a dietitian, students are required to complete the degree in Dietetics, followed by an approved Dietetic Internship.

Note: *The Department of Biochemistry does not expect to admit students to the Dietetics program for Fall 2008. Further information on the status of the program can be obtained from the Department.*

5.1.5.1 Admission to Dietetics

All applications for entry to the program for the Bachelor of Science in Dietetics must be submitted to the Head of the Department of Biochemistry by April 30 in any year.

Entrance to the program in Dietetics is on the basis of competition for a fixed number of places. The Admission Committee takes into account the applicant's academic background and information on an applicant's personal qualities and achievements as given by the applicant and by referees' reports.

- 1. To be eligible for consideration, an applicant must have completed a minimum of 30 credit hours in courses which have been taken or accepted for credit at a recognized university or university college before entry to the Dietetics program.
- 2. Students applying to enter are required to have successfully completed the following courses or their equivalents:
 - a. Chemistry 1050, 1051 (or Chemistry 1010, 1011 or 1201, 1001)
 - b. English 1080, 1110 (or equivalent)
 - c. Mathematics 1090, 1000 (or Mathematics 1000 and one elective)
 - d. Physics 1020 and 1021 (or Physics 1050 and 1051).
 - e. either Biology 1001 and 1002 or Psychology 1000 and 1001
- 3. No application will be considered from an applicant who cannot produce evidence that the above requirements have been met or will have been met by the time of entry into the Dietetics program.
- 4. After admission, the program will consist of two years of study at this University and a final year at Acadia University. The number of seats available at Acadia University is limited. When a student is accepted into the Dietetics program at Memorial University of Newfoundland, the year that student is expected to attend Acadia University will be set. No guarantee of space will be available in other years.

5.1.5.2 Registration and Promotion

The following regulations apply to the program courses taken at Memorial University of Newfoundland.

- 1. Biochemistry and Chemistry courses shall be taken in the program year indicated by the course number. Biology 1001 and 1002 must be completed by the end of the second year of the program. The remaining courses are to be scheduled so that the course load is five in each semester. Exceptions to this prescribed program, including specified course load, must have the approval of the Committee on Undergraduate Studies of the department. Students who have completed program courses in advance of admission to the program may arrange with the Committee a reduction in the required course load.
- 2. For promotion from each term the requirements are: the achievement of a passing grade in all courses; an overall average of at least 60% in those courses required in each academic term; and completion of the appropriate course load as outlined above.
- 3. Students who fail to achieve the standards outlined in the paragraph above will be required to withdraw from the program. They may be considered for readmission at which time they will normally be required to repeat the courses in which they failed, and/or to repeat courses which will raise the average to 60%, unless, in the opinion of the Head, a more meaningful course of study would be appropriate.
- 4. In order to be considered for readmission, students must formally apply for readmission to the program not later than the deadline date specified in the first paragraph of the Admission section of this program.

5.1.5.3 Major in Dietetics

- 1. **Required courses at Memorial University of Newfoundland:**
 - a. Biochemistry 2000, 2010, 2011, 2100, 2101, 3106, 3200, 3201, 3202, Medicine 310A, 310B.
 - b. Either Biochemistry 3054 or Biology 3050.
 - c. Biology 1001, 1002 (if not taken in first year).
 - d. Business 1000 and 2000.
 - e. Chemistry 2440 (or Chemistry 2400, 2401)
 - f. Statistics 2550 or equivalent.
 - g. Six credit hours in social science courses if Psychology 1000 and 1001 were not taken in first year.
 - h. Three credit hours in Computer Science.

Notes: 1. Students who choose to complete Chemistry 2400/2401 are advised to take the appropriate prerequisites for those courses.
2. For the purposes of a Biochemistry (Dietetics) degree, Medicine 310A and 310B count as Biochemistry courses.

The above courses must be completed before the year at Acadia University for both the General and the Honours Programs.

2. Required courses at Acadia University:

The equivalent of at least 18 senior level credit hours in nutrition and/or foods must be successfully completed at Acadia University. Courses to make up these credit hours are to be selected in consultation with faculty advisors at Memorial University of Newfoundland and Acadia University.

Note: 120 credit hours in courses must be obtained for the General Degree of Bachelor of Science (refer to Regulations for the General Degree of Bachelor of Science, Clause 1.

5.1.5.4 Honours Degree in Dietetics

Students normally should apply for an Honours program at the completion of their third year of studies. To be eligible for admission, students must be in Honours standing.

In addition to the courses required for the general degree, the program shall include: Either Biochemistry 499A/B or Biochemistry 4999 plus 3 additional credit hours in Nutrition at Memorial University of Newfoundland or Acadia University at the 4000 level.

The 60 credit hours in courses from clause 6. a. of the Regulations for the Honours degree of Bachelor of Science shall be chosen from the required Biochemistry courses in the program outlined above, the Nutrition and Foods courses at Acadia University, and Biology 3050.

5.1.6 Course List

In accordance with Senate's *Policy Regarding Inactive Courses*, the course descriptions for courses which have not been offered in the previous three academic years and which are not scheduled to be offered in the current academic year have been removed from the following listing. For information about any of these inactive courses, please contact the Head of the Department.

1430 Biochemistry for Nurses is an introduction to the chemistry and structure-function relationships of carbohydrates, lipids and proteins. It will examine the basic metabolism of carbohydrates and fats, with emphasis on the biochemical fluctuations that occur in human health and disease, and will include a brief introduction to molecular genetics. This course may not be used for credit to fulfil the requirements for a major in the Department of Biochemistry. Entry into this course is restricted to students in the BN (Collaborative) Program. Prospective fast-track program students should consult with the School of Nursing concerning admission to this course.
Prerequisite: Level 3 Chemistry or Chemistry 1010 or Chemistry 1810 or equivalent.

Lectures: Four hours per week

Note: Credit may be obtained for only one of Biochemistry 1430 and the former 2430.

2000 Principles of Food Science enables one to gain an understanding of the scope of Food Science as a discipline. Topics include introductions to chemistry, processing, analysis, microbiology, packaging, product development, sensory evaluation and quality control as they are related to Food Science.

Prerequisite: Chemistry 2400 or 2440.

Lectures: Three hours per week.

Laboratory: One period per week.

2010 Introductory Foods I is an introduction to the science of food and food preparation. Topics covered include fats and oils, simple and complex carbohydrates, fruits and vegetables, cereals and starches. Laboratory work applies scientific principles and theories to practical problems in food preparation.

Prerequisite: Chemistry 1011 or 1051.

Lectures: Three hours per week.

Laboratory: Three hours per week.

2011 Introductory Foods II is an introduction to the science of food and food preparation. Topics covered include proteins - dairy products, eggs, meats and fish, legumes, gelatin and flour proteins, batters and doughs, meal management and menu planning. Laboratory work applies scientific principles and theories to practical problems of food preparation.

Prerequisite: Chemistry 1011 or 1051; Biochemistry 2010.

Lectures: Three hours per week.

Laboratory: Three hours per week.

2100 Introduction to Molecular Biology and Genetics will cover the heritability of simple traits from phenotype to genotype; the discovery of DNA as the molecule of heredity; the structure and function of DNA; the elucidation of the genetic code; and the manipulation of DNA for recombinant DNA technology and biotechnology.

Prerequisites or co-requisites: Biochemistry 2101, Chemistry 2401, Physics 1021 or 1051. Students may replace the co-requisite Chemistry 2401 with Chemistry 2440 as a prerequisite. Chemistry 2440 may **not** be taken as a co-requisite of 2100.

Lectures: Three hours per week.

Laboratory: Three hours on alternate weeks.

2101 Introduction to Biochemistry is an introduction to the major organic substances of living organisms, proteins, carbohydrates and lipids: their structure, analysis and biochemical function. Other topics will include: enzymes; the biochemistry of membranes, including the plasma membrane and specialized intracellular membranes; and the biochemistry of selected differentiated cells.

Prerequisites: Chemistry 2400, 2401, or Chemistry 2440; and Physics 1020

or 1050, and 1021 (or 1051). Chemistry 2401 and Physics 1021 or 1051 can be done concurrently.

Lectures: Three hours per week.

Laboratory: One three-hour laboratory period on alternate weeks to illustrate concepts covered in the lectures.

Note: Credit may be obtained for only one of 2101, Pharmacy 2004, or the former Pharmacy 3110.

2600 Introduction to Human Nutrition (same as HKR 2600) gives an overview of human nutrition with an emphasis on topics of current interest. Students will gain an understanding of nutrition in the context of health maintenance across the life span. Topics covered will include nutrition during pregnancy, nutrition for infants, Canadian Recommended Nutrient Intakes / Dietary Reference Intakes, weight loss and weight gain, nutraceuticals and ergogenic aids.

Notes: 1. Credit can be received for only one of Biochemistry 2600, the former Kinesiology 2600, or HKR 2600.

2. Students who have completed Biochemistry 3200 or 3201 may not subsequently receive credit for Biochemistry 2600.

3. Students may not count Biochemistry 2600 among the 60 credit hours in Biochemistry courses required for Honours in Biochemistry, Honours in Nutrition, or Honours in Dietetics.

3052 Food Microbiology - inactive course.

3054 Fundamentals of Food Microbiology is an introduction to the basic principles of microbiology with an emphasis on the study of microorganisms that are found in foods. The role of microbes in food and food spoilage, and the role of food-borne pathogens in human illness and disease will each be discussed. Nutritional aspects of food-borne microorganisms will also be studied.

Lectures: Three hours per week.

Prerequisites: Biology 1002 and Biochemistry 2101.

Note: Credit can only be received for only one of Biochemistry 3052, 3054, Biology 3052, and the former Biochemistry 3401.

3105 Physical Biochemistry examines topics such as: types of intermolecular forces in biomolecules; the folding of biomolecules and the role of water; pH, buffers, and ionisation of biomolecules; thermodynamics: equilibria, coupled reactions, transport across membranes and redox reactions; and ligand binding. Other topics will include: size and shape of biomolecules; isotopes in biochemistry; and, spectroscopy of biomolecules.
Prerequisites: Biochemistry 2101; and Chemistry 2300 or Physics 2053.
Lectures: Three hours per week and a two hour problem-solving class.

3106 Metabolism examines the catabolism of carbohydrates, lipids and amino acids. Other topics will be: mitochondria, chloroplasts and ATP synthesis; biosynthesis of carbohydrates and lipids; metabolic specialization of differentiated cells and tissues; and, integration of metabolism.

Prerequisite: Biochemistry 2101.

Lectures: Three hours per week.

Practical classes: One three-hour laboratory or one-hour tutorial per week.

Note: Credit may be obtained for only one of Biochemistry 3106, the former Biochemistry 3102 or Pharmacy 3111.

3107 Nucleic Acid Biochemistry and Molecular Biology examines the structure, function and biochemistry of DNA and RNA and the biochemical processes in the flow of information from the gene to protein. These will include: DNA replication, recombination and repair processes; transcription of RNA and RNA splicing; and protein synthesis. The regulation of gene expression will also be covered at an introductory level. The course will also include an introduction to cloning methodology.
Prerequisite: Biochemistry 2101; and Biochemistry 2100 or Biology 2250.
Lectures: Three hours per week.

Laboratory: Up to four hours per week which will normally consist of one three hour laboratory period plus one additional hour on the following day.

3108 Molecular Biochemistry of the Cell focuses on the molecular biochemistry of intracellular regulation, including advances in topics such as signal transduction, apoptosis and cancer. Other topics will include protein

processing and sorting, cyclins, G-protein structure, function and regulation, cell adhesion molecules and the structure of the extracellular matrix.

Lectures: Three hours per week.

Prerequisites: Biochemistry 2100 or Biology 2250; and Biochemistry 2101.

311A/B Human Physiology (same as Medicine 310A/B) covers the properties of nerve and muscle cells, the special senses, blood and body fluids, and the nervous, cardiovascular, digestive, immune, respiratory, urinary, endocrine and reproductive systems. Integration of the body's systems in maintaining homeostasis is emphasized. Priority for entry into this course is given to Biochemistry, Nutrition, Dietetics, and other students who are interested in experimental science.

Prerequisite or Co-requisite: Biochemistry 2101.

Lectures: Three hours per week.

Laboratory: To be specified.

Note: *Credit may be obtained for only one of Biochemistry 311A/B or Medicine 310A/B.*

3200 Basic Human Nutrition I studies the nutrients essential to human health and well-being with emphasis on carbohydrates, proteins and lipids, -chemistry, dietary source, dietary requirements, metabolism, and physiological importance.

Prerequisite or Co-requisite: Biochemistry 2101 or Pharmacy 2004 or the former Pharmacy 3110.

Lectures: Three hours per week

3201 Basic Human Nutrition II studies the vitamins, minerals and trace elements essential to human health and well-being - chemistry, dietary source, dietary requirements, physiological role, and deficiency syndromes.

Co-requisite or prerequisite: Biochemistry 3106 or Pharmacy 3111.

Lectures: Three hours per week

3202 Community Nutrition examines nutritional assessment, nutrition education, and the role of community agencies and individuals in the dissemination of nutritional information. Survey methods and results will be discussed.

Co-requisites or prerequisites: Biochemistry 3201, and either Biochemistry 311B or Medicine 310B.

Prerequisite: Biochemistry 3200.

Lectures: Three hours per week.

Note: *Credit may be obtained for only one of Biochemistry 3202 and the former Biochemistry 4302.*

3402 Food Chemistry examines the following topics: water structure and the role of water in chemical reactions and mechanical properties of foods; chemistry and physical properties of carbohydrates, proteins and lipids; food dispersions; pigments and natural colorants; food flavour; enzyme properties and applications; vitamins and minerals; chemistry of enzymic and non-enzymic browning; characteristics of: muscle tissue, milk, eggs, bread and edible plant tissue; food additives; and, chemical changes in foods during processing.

Prerequisites: Biochemistry 2000, 2101, and either Chemistry 2440 or Chemistry 2401.

Lectures: Three hours per week.

Laboratory: One period per week.

4002 Biochemical Regulation examines metabolic regulation at the cellular and multicellular level. Topics will include: control theory; hormones: their biosynthesis and mechanism of action; signal transduction; and, endocrine coordination of metabolic processes. Principles will be illustrated by the use of case studies from the medical and veterinary literature.

Prerequisites: Biochemistry 2100 or Biology 2250; Biochemistry 3106.

Lectures: Two to three hours per week, together with assigned reading and case studies.

4101 Proteins will review the history of protein research and the general properties of proteins and include other topics such as: strategy and methods for purification; chemical structure, properties, modification and determination of the protein amino acids; sequencing strategy, chain cleavage methods and end group analysis; folding of the protein main chain and techniques to determine structure; and, the relationship between structure and function: protein filaments, motors and regulators. It will also cover disease-related proteins and other examples from the current literature.

Prerequisite: Biochemistry 3105.

Lectures: Two to three hours per week and assigned reading.

4102 Current Topics in Biochemistry is a seminar course in which faculty and students will discuss topics of current interest in the biochemical literature. Students will be responsible for reading and critically assessing recent literature.

Prerequisites: Admission to this course is restricted to Honours Biochemistry students in their final year or by permission of the Head.

4103 Prokaryotic Gene Regulation is a detailed and up-to-date treatment of the mechanisms of genetic regulation found in bacterial cells. The course will develop topics based on the evidence of bacterial genetics and modern molecular biological experiments. Topics may include: theory of mutations, RNA transcription, positive and negative regulation of transcription; regulation of protein synthesis; control of DNA replication; bacterial operons and regulons; developmental molecular biology in bacterial systems; and evolution and molecular biology of organelles.

Prerequisite: Biochemistry 3107.

Lectures: Three hours per week.

4104 Eukaryotic Gene Regulation and Developmental Biology details

the cellular and molecular aspects of eukaryotic gene regulation and development. Topics to be covered will include the DNA content and organization of eukaryotes, mechanisms controlling the expression of eukaryotic genetic information at the transcriptional and post-transcriptional levels, and the methodologies used to define these mechanisms. Detailed consideration will be given to the cell-surface events which regulate nuclear gene expression and cell lineage specification. Developmental mechanisms operating in a number of model systems will be discussed.

Prerequisite: Biochemistry 3107 or 3108.

Lectures: Three hours per week.

4105 Immunology (same as Pharmacy 4105) is taught and administered by the School of Pharmacy. The course is an introduction to the molecular and cellular basis of immunity and hypersensitivity, and will include a discussion of the manipulation of the immune system in the management and treatment of disease.

Lectures/Tutorials: Three per week.

Co-Requisites or prerequisites: Biochemistry 2101, and either Biochemistry 311B or Medicine 310B.

Note: *Credit may be obtained for only one of Biochemistry 4105, Pharmacy 4105 and the former Pharmacy 3105.*

4200 Bioenergetics and Biological Oxidation examines topics such as: respiration and electron transport; the functional organization of energy transducing membranes; the structure and function of flavoenzymes, cytochromes, iron-sulfur proteins and quinones; enzyme reduction of oxygen; and, free radicals in biological systems.

Prerequisite: Biochemistry 3106.

Lectures: Two to three hours per week and assigned reading.

4201 Membranes - Structure and Function examines the structure of model and biological membranes, the molecular interactions between membrane components and the effects of these interactions on the biophysical and functional properties of membranes. Other topics will include the structure-function of specialized membranous systems, such as lipoprotein, lung surfactant, and lipid rafts; membrane lipid composition in biochemical adaptation and function; and the role of membrane proteins in intracellular trafficking, receptor function, enzymatic activity and membrane-related diseases.

Prerequisite: Biochemistry 3105.

4210 Biochemical Research Techniques I is designed to familiarize students with methods used for the study of structural and molecular biology.

Prerequisites: Biochemistry 3105, 3107.

Lectures and laboratory periods: times as arranged.

Attendance is required.

4211 Biochemical Research Techniques II is designed to familiarize students with methods used for the study of cellular and subcellular metabolism. This course may include a research project.

Prerequisite: Biochemistry 3106.

Lectures and laboratory periods: times as arranged.

Attendance is required.

4220 Introduction to General and Autonomic Pharmacology (same as Medicine 4300) deals with the general principles of pharmacology (dose-response relationship, drug-receptor interaction, absorption, distribution, metabolism, excretion of drugs), and drugs that affect neuromuscular and autonomic neurotransmission, the cardiovascular, gastrointestinal, and central nervous systems, and autacoids/prostanoids.

Prerequisites: Biochemistry 311A/B or Medicine 310A/B or Pharmacy 2002/2003 (or the former Pharmacy 3201/3202).

Co-requisites: Biochemistry 3106 or Pharmacy 3111.

Lectures: Three hours per week.

Laboratory: Three hours per week.

Note: *Credit may be obtained for only one of Biochemistry 4220 or Medicine 4300.*

4300 Advanced Nutrition is a course in which current controversies and trends in human nutrition are presented and discussed using the scientific literature.

Prerequisites: Biochemistry 3200, 3201, and either Biochemistry 311B or Medicine 310B.

Lectures: Three hours per week.

4301 Nutrition and Disease is a course which addresses the scientific basis for nutritional intervention in chronic human disease.

Prerequisites: Biochemistry 3200, 3201, and either Biochemistry 311B or Medicine 310B.

Lectures: Three hours per week.

4400 Food Analysis - inactive course.

4502 Techniques in Nutrition Research is a seminar course in which faculty and students will discuss concepts and methods used in the study of nutrition. Students will be responsible for reading and critically assessing recent literature.

Prerequisite: Biochemistry 4301.

Admission to this course is restricted to Honours Nutrition students in their final year or by permission of the head.

499A and 499B Dissertation is a two-semester linked course (6 credit hours) based on independent study of a problem in Biochemistry. The subject of study will be decided in consultation with Faculty advisors and must be approved in advance by the Department, or both Departments in

the case of a Joint Honours degree. This dissertation is obligatory for Honours students in Biochemistry. The dissertation will be submitted as a formal written report accompanied by appropriate illustration before the end of the tenth week of the second semester. Before the end of his/her final semester the student will give an oral presentation of his/her research. Admission to this course is restricted to Honours students in their final year or by permission of the Head.

Note: *Credit may be obtained for only one of Biochemistry 499B or Biochemistry 4999.*

Dietetics and Nutrition. The dissertation will be based on independent study of a problem in Dietetics or Nutrition. The subject of study will be decided in consultation with Faculty advisors and must be approved in advance by the Department. The dissertation will be submitted as a formal written report accompanied by appropriate illustrations before the end of the semester. Admission to this course is restricted to Honours students in their final year or by permission of the Head.

Note: *Credit may be obtained for only one of Biochemistry 499B or Biochemistry 4999.*

4999 Dissertation is a three-credit hour dissertation for Honours students in

5.2 Biology

5.2.1 Programs in Biology

The following undergraduate programs are available in the Department:

1. Major or Honours in Biology
2. Joint Honours in Biology and Earth Sciences (Geology)
3. Joint Honours in Biology and Psychology
4. Joint Honours in Biology and Psychology (Behavioural Neuroscience)
5. Joint Honours in Biology and Statistics
6. Joint Honours in Cell Biology and Biochemistry
7. Minor in Biology

Details of joint programs are given after the **Regulations for the Honours Degree of Bachelor of Science**.

5.2.2 Entrance Requirements

Entry to the Biology Majors Program is competitive and based on academic standing.

To be considered for admission to the program students must have completed Biology 1001/1002 with an average of at least 65%. In addition, applicants will normally have completed the following courses (or their equivalents) and must have a minimum overall average of 60% in these courses.

1. English 1080, 1110 or equivalent
2. Mathematics 1090 and Mathematics 1000 (or Mathematics 1000 only)
3. Chemistry 1010/1011 or Chemistry 1050/1051 or Physics 1020/1021 or Physics 1050/1051
4. If Mathematics 1000 taken, any one other first year course.

Chemistry 1010/1011 (or 1050/1051) should be taken in the first year, as it is a prerequisite for other required courses in the Biology program, and delaying chemistry until second year may make it difficult to complete the program in the normal eight semesters.

5.2.3 Minor in Biology

A minor in Biology will consist of 24 credit hours in Biology courses: 1001 and 1002 (or equivalent) plus any 18 credit hours chosen from the list of Biology courses except 2040, 2041 and 2120. The choice of courses must be made in consultation with the Head of Biology or delegate and it is recommended (but not required) that students take at least two Biology courses at the 3000 level or above

5.2.4 General Degree - Major in Biology

Each Biology Major is assigned a faculty advisor who should be consulted on academic problems, including course selection. All students majoring in Biology are required to complete a minimum of 45 credit hours in courses from the Biology Department offering. Those 45 credit hours must include Biology 1001/1002 or their equivalents, the 15 credit hours in core courses listed below, and 24 credit hours in biology electives.

Biology Core (15 credit hours): Biology 2060, 2250, 2600, 2900, plus one of Biology 3401, 3402, 4245 and 4404.

All majors must also successfully complete the following courses or their equivalents:

1. English 1080 and 1110 (or equivalent)
2. Physics 1020/1021 (or 1050/1051)
3. Mathematics 1000
4. Chemistry 1010/1011 (or 1050/1051), 2440
5. Statistics 2550
6. Biochemistry 2101 and 3106
7. Extra Science courses as necessary to fulfill the requirement for 78 credit hours in Science as stipulated in Clause 3. a. of the **Regulations for the General Degree of Bachelor of Science**.

It is recommended, but not required, that a Computer Science course be included and the Biology Department strongly recommends Computer Science 2650.

Note: *To minimize timetabling problems, students on the St. John's campus are advised to take Biology 2250 and 2600 in their third semester (Fall), and 2060 and 2900 in their fourth semester (Winter).*

5.2.5 Honours Degrees

The attention of students wishing to take Honours is called to those sections of the Calendar dealing with Regulations for the Degree of Bachelor of Science (Honours).

Sixty-nine credit hours in courses, including the 6 first year credit hours and the 15 required core credit hours outlined in the regulations for the General Degree, and the Honours Dissertation (Biology 499A/499B), shall be taken from the Department of Biology offering. Students may elect to complete an Honours Program in Biology or in one of the joint Honours Programs listed under the heading "Programs in Biology". Programs of students taking Honours shall be drawn up in consultation with the student's supervisor, and must be approved by the Head of the Department (or his/her delegate) in accordance with Regulation 1. b. of the **Regulations for the Honours Degree of Bachelor of Science**.

Note: *Some Graduate Courses may be taken in the final year of the Honours Program with the permission of the Head of the Department and the course instructor.*

A dissertation (6 credit hours) is to be presented on some original piece of work undertaken by the candidate, under the guidance of a faculty member of the department, as appointed by the Head of Department. For students electing to take one of the Joint Honours Programs, the dissertation shall be on a topic representative of the selected program. The Department of Biology considers the dissertation to be an important part of the Honours Program.

The dissertation will be based on a 6 credit hours course (Biology 499A/499B). It will involve directed reading relevant to the dissertation topic, preparation of a dissertation outline, supervised research, data synthesis and interpretation, and preparation and defence of the dissertation.

Two typed copies of the dissertation, complete with figures and tables, are to be submitted not less than two weeks before the end of lectures in the semester in which the candidate is registered for Biology 499B. These copies must be submitted to the Head of Department, and must have met the prior approval of the candidate's Honours supervisor.

Before the last day for examinations in the semester, the candidate will be examined orally on the contents of the dissertation. The examining committee shall consist of the Head of the Department, or delegate, the candidate's supervisor, and an examiner appointed by the Head of the Department in consultation with the candidate's supervisor.

5.2.6 Honours in Biology

Students seeking the Honours Degree in Biology must satisfactorily complete Biology 1001/1002 (or equivalents) and the 15 credit hours of core Biology courses. The remaining 48 credit hours in Biology courses, which must include the dissertation (499A/499B), may be taken as electives from the Biology offering, on the advice of the supervisor. Additional courses from other departments required for the Honours Degree in Biology include those given for the Major in Biology Program as outlined above.

An Honours degree in Biology may comprise a broadly based selection of courses according to the students interests, or it may be more narrowly focused. An Honours student may focus on any area of Biology where an appropriate supervisor can be found. All Honours students should choose courses in consultation with their supervisors, but it is particularly important that students wishing to focus within the Honours degree should discuss course selection with an Honours supervisor within their area of interest.

As a guide to course selection a number of foci are set out below with some appropriate courses. Note that students are not limited to these areas but may focus their programs wherever they wish provided that (i) an appropriate supervisor is available, (ii) consultation with that supervisor takes place, and (iii) the resources of the Department, as determined by the Head of Department, are appropriate and adequate. Area of focus will not be indicated on the students' transcript.

Focus in Marine Biology

Students wishing to focus on marine biology in their Biology Honours program must fulfil all the requirements for an Honours degree in Biology as set out above. The following courses are recommended for this area of interest: Biology 2010, 2122, 2210, 3050, 3295, 3620, 3709, 3710, 3711, 3712, 4012, 4360, 4505, 4510, 4600, 4601, 4605, 4701, 4750, 4810. (Note: this list is only advisory; these are not required courses).

Focus in Cell/Molecular Biology

Students wishing to focus on cell biology/molecular biology in their Biology Honours program must fulfil all the requirements for an Honours degree in Biology as set out above. The following courses are recommended for this area of interest: Biology 3050, either 3401 or 3402, 3500, 3530, 3540, 3620, 4000, 4040, 4241, 4245, 4402, 4404, 4605. (Note: this list is only advisory; these are not required courses).

Focus in Ecology - Evolution

Students wishing to focus on ecology and/or evolution in their Biology Honours program must fulfil all the requirements for an Honours degree in Biology as set out above. The following courses are recommended for this area of interest: Biology 3041, 3050, 3295, 3610, 3620, 3709, 3710, 3711, 3712, 3714, 4040, 4150, 4306, 4360, 4504, 4605; either 4810 or 4820. (Note: this list is only advisory; these are not required courses).

5.2.7 Course List

In accordance with Senate's *Policy Regarding Inactive Courses*, the course descriptions for courses which have not been offered in the previous three academic years and which are not scheduled to be offered in the current academic year have been removed from the following listing. For information about any of these inactive courses, please contact the Head of the Department.

- Notes: 1. *Students may obtain credit for only 6 1000-level credit hours in Biology. Normally, these courses will be Biology 1001-1002, which are prerequisite to all higher courses in Biology, except where noted below.*
2. *According to the nature of particular courses, the specified number of laboratory hours may consist of some combination of laboratory work, seminars or directed independent study relevant to the practical aspects of the subject matter.*

1001-1002 Principles of Biology is an introduction to the science of Biology, including a discussion of the unity, diversity and evolution of living organisms.

Three hours of lecture and a three-hour laboratory per week.

Note: *Biology 1001 is a prerequisite for Biology 1002.*

2010 Biology of Plants is a study of the structure, function and reproductive biology of plants, with emphasis on the vascular plants, and on their relationship to environment and human activities.

Three hours of lecture and a three-hour laboratory per week.

Prerequisites: Biology 1001 and 1002; Chemistry 1010 or 1050 (or 1000).

2040 Modern Biology and Human Society I examines various aspects of the human body, and the implications of modern biological research for human beings. Topics include cancer; diet and nutrition and associated diseases; circulatory disease, immunity, human genetics, biorhythms, new diseases, genetic engineering and reproductive engineering.

Three hours of lectures/seminars per week.

Note: *Biology 2040 is not acceptable as one of the required courses for the*

Minor, Major or Honours programs in Biology. There are no prerequisites for this course.

2041 Modern Biology and Human Society II examines the origins and consequences of the environmental crisis of the 20th century. Topics include the population explosion, energy, material cycles, air and water and land pollution, global food supplies, the fisheries, wildlands, renewable and non-renewable resources, environmental ethics.

Three hours of lecture/seminar per week.

Note: *Biology 2041 is not acceptable as one of the required courses for the Minor, Major or Honours programs in Biology. There are no prerequisites for this course.*

2060 Principles of Cell Biology is a modern view of the biology of eukaryotic cells, organelles and molecules and their interactions in the functioning of living organisms.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 1001, 1002 and 2250; Chemistry 2440 or 2400

Prerequisites or co-requisites: Physics 1021 or 1051; Biochemistry 2101

Note: *Credit may not be obtained for both Biology 2060 and the former Biology 3060.*

2120 Biology for Students of Earth Sciences is an introduction of the principles of Biology for students in Earth Sciences. Topics will include principles of classification, levels of biological organization, fundamental characteristics of living organisms and basic concepts in ecology.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Earth Science major; Earth Sciences 1001 or 1002 or permission of the Head of Department.

Notes: 1. *Entry to this course is restricted to Earth Sciences majors, or by permission of the Head of Department.*

2. *This course may not be used for credit by Biology Majors or Minors.*

3. *Credit may not be obtained for both Biology 2120 and either of Biology 1001 or 1002.*

2122 Biology of Invertebrates is a study of the invertebrates with emphasis

on structure and function, adaptations and life histories. The laboratories will present a broad survey of the major invertebrate groups.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 1001 and 1002.

Note: *Credit may not be obtained for both Biology 2122 and the former Biology 3122.*

2210 Biology of Vertebrates is a study of the vertebrates, with emphasis on structure and function, adaptations and life histories.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 1001 and 1002.

Note: *Credit may not be obtained for both Biology 2210 and the former Biology 3210.*

2250 Principles of Genetics is an introduction to Mendelian and molecular genetics. Phenotype and genotype, behaviour of alleles in genetic crosses, chromosome theory of inheritance, genetic linkage, molecular biology of DNA, RNA and protein, molecular basis of mutation, recombinant DNA, applications of genetic biotechnology.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 1001 and 1002; Chemistry 1010 and 1011 (or 1050/1051).

Prerequisites or co-requisites: Chemistry 2440 or 2400.

Note: *Credit may not be obtained for both Biology 2250 and the former Biology 3250.*

2600 Principles of Ecology is a conceptual course introducing the principles of ecology, including theoretical, functional and empirical approaches.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 1001 and 1002.

Note: *Credit may not be obtained for both Biology 2600 and the former Biology 3600.*

2900 Principles of Evolution and Systematics is an introduction to the processes and patterns of evolution, and the principles of classification. Natural selection and other microevolutionary processes, variation and adaptation, species and speciation, phylogenetic systematics, reconstruction of phylogeny, macro-evolutionary patterns in the fossil record and their interpretation.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 1001, 1002 and 2250.

Prerequisite or co-requisite: Statistics 2550 (or equivalent)

Note: *Credit may not be obtained for both Biology 2900 and the former Biology 3900.*

3041 Boreal Flora covers the identification of the terrestrial vascular plants of Newfoundland and Labrador. Various aspects of floral biology, and the use of dichotomous keys will also be covered.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 1001 and 1002.

Note: *Credit can be obtained for only one of Biology 3041 or ENVS 3110.*

3050 Introduction to Microbiology is a course in which the basic principles underlying microbial life are studied. Aspects include structure, function, bioenergetics and growth with an emphasis on prokaryotes. Also studied are viruses, microbial diseases, introductory principles of immunology and the control of microorganisms. The laboratory sessions provide training in culture and determinative techniques using microorganisms.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 1001 and 1002; Chemistry 2440 or 2400; and Chemistry 2401. Chemistry 2401 may be used as a co-requisite.

3052 Food Microbiology - inactive course.

3053 Microbiology for Nurses examines the fundamentals of microbiology with an emphasis on medical microbiology. The course will include topics such as: host responses to infections, human diseases caused by microorganisms, and the control and exploitation of microorganisms. Entrance is restricted to Nursing students in the Collaborative B.N. program. Lecture: Three hours per week. Laboratories: Two hours per week.

Note: *Biology 3053 is not acceptable as one of the required courses for the Minor, Major or Honours programs in Biology, nor is it acceptable for any of the joint programs between Biology and other disciplines.*

3160 Insect Morphology and Physiology is an examination of the structural organization and physiology of insects. Comparisons with other arthropod classes will be drawn where appropriate.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2122.

Note: *Credit may not be obtained for both Biology 3160 and the former Biology 3150. It is recommended that students enrolling in Biology 3160 have already completed one of Biology 3401, Biology 3402, Biology 4404, or Biochemistry 3106.*

3202 Comparative Vertebrate Anatomy examines the phylogenetic development and comparative anatomy of the vertebrates.

Three hours of lecture and four hours of laboratory per week.

Prerequisites: Biology 1001 and 1002.

Note: *Credit may not be obtained for this course and either of the former Biology 3200 or the former Biology 3201.*

3295 Population and Evolutionary Ecology is an introduction to the theory and principles of evolutionary ecology and population dynamics.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2600; at least one of Biology 2010, 2122 or 2210.

Note: *Credit may not be obtained for both Biology 3295 and the former Biology 4290.*

3401 Comparative Animal Physiology is a comparative study of the basic physiological processes, with special attention paid to those strategies invoked by animals which enable them to adapt to environmental changes.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2060 and 2210.

Prerequisite or co-requisite: Biochemistry 3106.

Note: *Credit may not be obtained for both Biology 3401 and the former Biology 4401.*

3402 Principles of Plant Physiology is a consideration of the principles of plant physiology, including water relations, nutrition, metabolism, growth and development.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2010 and 2060.

Prerequisite or co-requisite: Biochemistry 3106.

Note: *Credit may not be obtained for both Biology 3402 and the former Biology 4403.*

3500 Histology is a study of microstructure and ultrastructure of tissues and organ systems in vertebrates, particularly mammals, with emphasis on correlating structure and function.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2060 and 2210.

3530 Developmental Biology is a study of developmental systems in protists, plants and animals with a focus on the underlying principles and molecular mechanisms involved in cellular differentiation, morphogenesis and growth.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2060 and either 2250 or Biochemistry 2100.

3540 Histotechnology is a course on the theory and practice of preparatory techniques for microscopical study of tissues and cells. Experimental approach in cytochemical localization of cell components and introduction to electron microscopy.

Three hours of lecture and three hours of laboratory per week.

Prerequisite: Biology 3500.

3610 Boreal Ecology is a study of the principal features of terrestrial ecosystems, with emphasis on the boreal region.

This course may be offered in a usual 13 week semester or as a two-week field course.

Either: three hours of lecture and three hours of laboratory per week.

Or: a two week field course that embodies equivalent instructional time.

Prerequisites: Biology 2010, 2250, 2600 and 2900; Statistics 2550 or equivalent.

Note: *Credit can be obtained for only one of Biology 3610 or ENVS 3131.*

3620 Aquatic Microbial Ecology is a study of the nature, distribution and activities of microorganisms in the freshwater and marine environments. Field and laboratory work illustrate some of the investigative techniques used in this area of study.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2600 and 3050; Statistics 2550 or equivalent.

Note: *Credit may not be obtained for both Biology 3620 and the former Biology 3603.*

3709 Field Course in Marine Principles and Techniques begins with a two-week field school immediately prior to the beginning of the Fall Semester. In the Fall Semester there are follow-up lectures, readings and submission of reports. The course is designed to introduce the principal marine environments, organisms and techniques. It is strongly recommended that this course be taken before either Biology 3710, 3711 or 4810. May be taken only with the permission of the Head of Department.

Prerequisites: Biology 2600; Statistics 2550 or equivalent.

3710 The Aquatic Environment examines the abiotic properties of marine and freshwater systems, including basin formation, chemical properties, circulation and dynamics, sampling techniques and the special characteristics of estuarine systems. Emphasis will be on large bodies of water, but stream hydrology will also be discussed.

This course may be offered in a usual 13 week semester or as a two-week field course.

Either: three hours of lecture and three hours of laboratory per week.

Or: a two-week field course that embodies equivalent instructional time.

Prerequisites: Physics 1021 or 1051; Chemistry 1011 or 1051; Biology 2600 as prerequisite or co-requisite.

Note: *Credit may not be obtained for both Biology 3710 and the former Biology 3700.*

3711 The Ecology of Open Waters is a comparative survey of the major biological groups in open water aquatic habitats, both freshwater and marine, with community structure, trophic interactions and energy flow as central themes. Strategies for measuring population levels and production and for constructing both conceptual and quantitative models of ecosystems and their components are emphasized.

This course may be offered in a usual 13 week semester or as a two-week field course.

Either: three hours of lecture and three hours of laboratory per week.

Or: a two-week field course that embodies equivalent instructional time.

Prerequisites: Biology 2122, 2600 and 3710.

Note: *Credit may not be obtained for both Biology 3711 and the former*

Biology 3701.

3712 Benthic Biology examines the biology of the aquatic benthos (bottom-dwelling organisms); their origins, adaptations, life histories and ecological roles.

This course may be offered in a usual 13 week semester or as a two-week field course.

Either: three hours of lecture and three hours of laboratory per week.

Or: a two-week field course that embodies equivalent instructional time.

Prerequisites: Biology 2122, 2600 and 3710.

Note: *Credit may not be obtained for both Biology 3712 and the former Biology 3630.*

3714 Estuarine Fish Ecology Field Course examines community structure, function and distribution of northern coastal fishes in fjords and estuarine environments. Emphasis on sampling, field techniques, taxonomy, quantitative characterization, adaptations and habitat relationships. A comparative approach will contrast fish communities from other areas. To be held as a two week field course.

Prerequisite/co-requisite: Biology 2600.

3750 Animal Behaviour I is an introduction to the mechanisms and development of the behaviour of animals. Topics include: the history of ethology and comparative psychology, methods of animal behaviour study, behaviour of animals in relation to physiology, sensory function, learning, communication, orientation, and other areas in biology and psychology.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 1001 and 1002; Statistics 2550 or equivalent.

Note: *Credit may be obtained for only one of Biology 3750 or Psychology 3750 and Psychology 4770.*

3811 Paleontology (W) (same as Earth Sciences 3811) is taught and administered by the Department of Earth Sciences.

Prerequisites: EITHER Earth Sciences 1002 and Biology 2120 (or Biology 1001 and 1002), OR Biology 2122 and 2210.

Note: *Credit may be obtained for only one of Biology 3811, the former Biology 3800, and the former Earth Sciences 3801.*

4000 Bacterial Systematics is a study of bacterial classification, nomenclature and identification. Subjects include classical and numerical taxonomy, aerobic and anaerobic culture techniques, phage typing, serotyping and the significance of genetic relatedness. The laboratory work presents the techniques of determinative bacteriology.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2250 and 3050.

4012 Phycology studies the biology of the algae. A study of the structure, reproduction and evolution of the major divisions of the algae. Aspects of algal physiology and ecology relating to how algae are adapted to life in freshwater, marine and symbiotic environments, together with economic aspects of phycology, will also be covered. The laboratories will emphasize the recognition and identification of representative species of the major algal divisions with a bias towards local species. There will be field trips to collect material in local marine and freshwater environments.

This course may be offered in a usual 13 week semester or as a two-week field course.

Either: three hours of lecture and three hours of laboratory per week.

Or: a two-week field course that embodies equivalent instructional time.

Prerequisites: Biology 2060 and 2600.

4014 Biology and Ecology of Boreal and Arctic Seaweeds is a field course examination of seaweed biology and ecology with special study of living specimens in estuarine, fjordic and exposed coastal sites, demonstrating their physiological and ecological adaptations to cold-water habitats. This course is offered at the Bonne Bay Marine Station during the Summer Semester with two weeks of instruction followed by a week to complete course requirements.

Prerequisite: Biology 2600 or equivalent.

4040 Mycology is a study of the physiology, morphogenesis, nature of plant and animal parasitism, ecology and taxonomy of terrestrial and freshwater fungi.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2060 and 3050.

Note: *Credit may not be obtained for both Biology 4040 and the former Biology 3020.*

4122 Advanced Topics in Marine Invertebrates provides an in-depth examination of physiological, ecological and behavioural adaptations in marine invertebrates. Lectures will be combine with discussions of relevant papers from the primary literature on topics of current interest, which may relate to functional morphology, ecology, evolution and natural history. Students will also gain practical research experience through the study of live and preserved animals.

Three hours of lectures and three hours of laboratory per week.

Prerequisites: Biology 2122, 2600 and 2900.

4141 Nematology is a study of plant parasitic, insect parasitic and free-living marine, freshwater and terrestrial nematodes, with emphasis on taxonomy, biology, economic importance, control methodologies and environmental applications.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2010, 2122 and 2600.

4150 Insect Systematics and Ecology is a study of the classification, ecology and behaviour of insects with special emphasis on the boreal fauna.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2122 and 2600.

Note: *Credit may not be obtained for both Biology 4150 and the former Biology 4140.*

4180 General Parasitology is an examination of parasitism as a way of life, with emphasis on classification, structural adaptation, life cycles and ecology.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2122, 2210 and 2600.

4182 Fisheries and Wildlife Parasitology is a study of the important parasites of fish and other wildlife and their impact on both individuals and populations.

Three hours of lecture and three hours of laboratory per week.

Prerequisite: Biology 4180.

4200 Immunology is a study of vertebrate and invertebrate immune systems including antigens and antibodies and their reactions.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2060 and Biology 3050.

4241 Advanced Genetics has advanced topics in modern genetic analysis, including regulation of gene expression, developmental genetics, molecular basis of inherited disease, genomics, immuni-genetics, behavioural genetics, and molecular evolution.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2250; Biochemistry 2101.

4245 Biophysics is an examination of the physical properties involved in defining diffusion, membrane properties, electrochemical potentials and the processes of bioenergetics within cells and organelles. Selected topics in biomechanics and the functioning of whole organisms with respect to size, shape, support, orientation, transport and motility.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2060; Biochemistry 2101.

4250 Evolutionary Genetics has advanced topics in the study of micro and macro-evolutionary phenomena. Genetic variation in natural populations; theory of genetic drift, mutation, migration, inbreeding, and natural selection; neutral theory of molecular evolution, patterns of nucleotide substitution, heritability and quantitative genetics.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2250 and 2900.

4270 History of Biology is a consideration of the development of biological concepts as interactions between observations, philosophical systems and cultural environment. This course will normally require students to make verbal presentations to the class, participate in discussions and submit written papers. May be taken only with the permission of the Instructor.

Three hours of lecture plus one three-hour seminar per week.

Prerequisites: A minimum of 90 credit hours overall including a minimum of nine credit hours from any of Biology 2010, 2122, 2210, 2600 and including a minimum of six credit hours in Biology at the 3000 level or above, plus the permission of the Instructor.

4306 Applied Biology is an examination of how biological and other sciences are applied to the problems of management and utilization of organisms at both the individual and systems level to meet human needs.

Prerequisites: Biology 2060, 2250, 2600, 2900 and one of Biology 2010, 2122 or 2210.

Note: *Credit may not be obtained for Biology 4306 and either of the former Biology 4303 or the former Biology 4304.*

4360 Community and Ecosystem Ecology is a study of the basic principles, patterns and processes of ecological communities and ecosystems.

Three hours of lecture plus a seminar/discussion group each week.

Prerequisites: Biology 2250, 2600 and 2900 and one of Biology 2010, 2122 or 2210; Statistics 2550 or equivalent.

4402 Electron Microscopy in Life Sciences - inactive course.

4404 Microbial Physiology is a study of the structure and growth of microorganisms. Subjects include metabolic diversity and functions of components and organelles. The physiology of microbes interacting with their environment is emphasized. Quantitative experimental methodology is studied in the laboratory.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2250 and 3050; Biochemistry 3106.

4505 Systematics and Biogeography is a study of the geographical distributions of plants and animals with particular reference to temporal and spatial variability and to theories advanced to explain historical and recent distribution patterns.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2250, 2600, 2900 and one of Biology 2010, 2122 or 2210.

Note: *Credit may not be obtained for both Biology 4505 and Geography 4170.*

4510 Distribution Patterns in the Sea is an ecological approach to the description and understanding of biogeographic patterns in the sea. Lectures and discussions will focus on what the main patterns are and how they are determined, aspects of the ocean environment that contribute to pattern, how lifestyles are adapted to oceanic conditions, diversity and

dispersal, analytical techniques, and practical geographic problems concerning the exploitation and management of marine resources. It is recommended (but not required) that students take Biology 3710, 3711 and 4505 beforehand.

Three hours of lecture/seminar and a three hour laboratory/discussion session each week.

Prerequisite or co-requisite: Biology 4605.

4450 Principles of Endocrinology comprises an introduction to basic concepts concerned with how chemical messages are transmitted and received between cells to coordinate body functions. Hormonal control of adaptation, reproduction, metabolism, growth, digestion, and electrolyte homeostasis will be discussed. Although the endocrinology of invertebrates and lower vertebrates will be mentioned as appropriate, the main emphasis will be on mammalian and human endocrinology at the level of the whole organism.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2122 and 3401; Biochemistry 3106.

4600 Ichthyology is the study of fishes: taxonomy, life histories, evolution, behaviour and zoogeography.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2210 and 2600.

4601 Functional Biology of Fish is an introduction to anatomical, physiological and cellular aspects of selected processes in the life cycle of fishes.

Prerequisites: Biology 2060, 2210, and 3401.

4605 Quantitative Methods in Biology (same as Statistics 4581 and the former Statistics 4605) is quantitative reasoning using verbal, graphical and statistical models of scaled quantities (units and dimensions). Exploratory and confirmatory analysis of field and laboratory data. Hypothesis testing, including randomization tests. Topics include the general linear model (t-tests, ancova etc), correlation, autocorrelation, geographic statistics, estimates of population size and multivariate methods.

Three hours of lecture and three hours of laboratory per week.

Prerequisite: Statistics 2550.

4620 Ornithology examines structure, classification, evolution, ecology and behaviour of birds, with particular reference to those of economic importance. Identification of the birds of Eastern Canada.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2210 and 2600.

4630 Mammalogy examines evolution, systematics, life histories and distribution of mammals, with particular emphasis on eastern North American forms.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 2210 and 2600.

4650 Conservation in Biology and Geography (same as Geography 4650) is an examination of how biological and geographical principles can be applied to conserving biological diversity in the natural world under conditions of exploitation and habitat loss. Special emphasis will be given to relevant provincial examples.

Three hours of lecture per week and 3 hours of seminar/discussion group per week.

Prerequisites: 30 credit hours in either Biology or Geography.

4701 Animal Behaviour II is an examination of the behaviour of animals with particular emphasis on evolution and ecology. Topics include behavioural genetics and evolution, reproductive strategies, social behaviour, habitat selection, territoriality, foraging behaviour, and other topics in biology and psychology.

Three hours of lecture and three hours of laboratory per week.

Prerequisites: Biology 3750 or Psychology 4770.

4710 Experimental Marine Ecology of Newfoundland Waters is a two-week field course examines the ecology of cold ocean environments, focusing on energy flux through marine pelagic and benthic flora and fauna of Newfoundland waters, and how the dynamics of this environment influence linkages among organisms in different habitats. The course will be field intensive with some lecture component and a strong hands-on field

component. Students will identify local organisms and study how and why they vary in time and space. This course will be offered during two weeks of the Spring semester.

Prerequisite/co-requisite: Biology 2600.

4750 Fisheries Ecology is the application of ecological principles to the problem of managing exploited fish populations. Laboratory exercises will be based on a simulation approach to fisheries problems using computer and animal models.

Three hours of lecture and three hours of laboratory per week.

Prerequisite: Biology 2600.

4800 Advanced Palaeontology (same as Earth Sciences 4800) is taught and administered by the Department of Earth Sciences.

Prerequisites: Earth Science/Biology 3811, and one of Statistics 2510, Statistics 2550 or Mathematics 2000

4810 Research Field Course in Marine Biology will consist of an intensive two-week field school designed to acquaint students with marine field research, experimental design, methodology and data analysis. Emphasis will be placed on individual projects. Projects must be designed and approved prior to the commencement of the course and will involve a written report. May be taken only with permission of the Head of Department. At the discretion of the Head of Department, another recognized field course may be substituted for Biology 4810.

Prerequisites: Biology 3710 and any two of Biology 2010, 2122 or 2210. It is strongly recommended that students take Biology 3709 before 4810.

4820 Field Course in Terrestrial Biology will begin with a three-week field school immediately prior to the beginning of the Fall Semester. It is designed to acquaint students with terrestrial organisms and environments, and emphasis will be placed on survey and sampling techniques. In the Fall Semester the material and data collected in the field will be used in lecture and laboratory periods dealing with identification, analytical methods, and report compilation.

Prerequisites: Biology 2010, 2122, 2210, 2600 and permission of the Head of the Department.

Recommended: Biology 4605.

4822 Internship in Biology is an external applied laboratory where a student works with professionals on a problem or problems in biological research. Co-operating agencies may include Environment Canada, Fisheries and Oceans Canada, Agriculture Canada, the Provincial Departments of Fisheries and Forestry, and others. The student will have a supervisor within the Department and one in the co-operating agency, and will be expected to write a scientific account detailing the particulars of the work experience. The arrangements for the position must be agreed upon, and a project proposal approved, by the Head of the Department or delegate prior to registration for the course. Enrolment will be dependent upon the availability of suitable positions, and will be limited to students in the Honours Program. This course can be done in any semester, and carries 3 credit hours.

4900 Research Methods in Genetic Biotechnology will include DNA extraction, DNA amplification by the Polymerase Chain Reaction (PCR), DNA cloning, DNA sequence analysis and Bioinformatics. Additional modules in gene expression and re-sequencing chip technologies may be included. This will be offered on campus as a three week course. Entry to the course will be by permission of the Head of the Department or delegate and preference will be given to senior students.

Prerequisites: Biology 2060, Biology 2250 or Biochemistry 2100.

4910-4920 Special Topics in Biology will be given for senior undergraduates and will be in a two-week format which will involve equivalent instruction time as a course on campus. These courses will cover a range of topics in specialized fields in Biology and may be offered at the Bonne Bay Field Station, at the Harlow campus or elsewhere as appropriate. They may be taught by visiting specialists when available.

499A and 499B Honours Dissertation is available only to students in the Honours Program. Requirements for the Dissertation are outlined under **Honours Degrees**.

5.3 Chemistry

5.3.1 Programs in Chemistry

The following undergraduate programs are available in the department:

1. Major* or Honours* in Chemistry
2. Joint Honours in Chemistry and Earth Sciences*
3. Joint Honours in Chemistry and Applied Mathematics*
4. Joint Honours in Chemistry and Biochemistry*
5. Joint Honours in Chemistry and Physics*
6. Minor in Chemistry

* These programs are accredited by the Canadian Society for Chemistry.

Details of joint programs are given after the Honours B.Sc. Regulations.

5.3.2 Undergraduate Handbook

Additional information about the undergraduate program, individual courses and suggested timetables can be found in the Department of Chemistry Undergraduate Handbook which is available on the web at www.chem.mun.ca.

5.3.3 Faculty Advisors

Each student majoring in Chemistry will be assigned a Faculty Advisor who should be consulted on all academic matters. Individual programs must be drawn up in consultation with the advisor.

Note: *Students who have obtained a grade of 3 or better on the Advanced Placement courses in Chemistry will normally be eligible for direct entry into Chemistry 1031 or second year courses. Such students must consult the department before registration.*

5.3.4 Minor in Chemistry

Candidates who take a minor in Chemistry will complete Chemistry 1050 and 1051 (or 1010, 1011 and 1031) or equivalent, 2400, 2401, 2210, 2300 and 6 credit hours in courses chosen from 3100, 3211, 3300, 3301, 3410, 3411 and 3500.

5.3.5 General Degree - Major in Chemistry

The courses required for a Major in Chemistry are:

1. Chemistry 1050 and 1051 (or 1010, 1011 and 1031) or equivalent, 2300, 2210, 2400, 2401, 3100, 3211, 3300, 3301, 3410, 3411, 3500 and 4110.
2. Physics 1050 (or 1020 and 1021) and 1051.
3. Mathematics 1000, 1001, 2000, 2050 and Applied Mathematics 3260.
4. Biochemistry 2101

Recommended courses: Mathematics 2051, Physics 2820 and/or 2750, and 6 credit hours in one of the following languages: French, German, or Russian.

Students considering declaring Chemistry as their Major are encouraged to contact either the Department Head or the Deputy Head (Undergraduate Studies).

5.3.6 Honours Degree in Chemistry

Students wishing to take Honours should consult those sections of the Calendar dealing with Regulations for the Honours Degree of Bachelor of Science. The Honours program in Chemistry consists of at least 66 credit hours in Chemistry courses. It is recommended that candidates also take groups of 18 or more credit hours in each of two other science subjects, normally Biochemistry, Biology, Earth Sciences, Physics, or Mathematics.

Required Courses

1. Chemistry 1050 and 1051 (or 1010, 1011 and 1031) or equivalent, 2300, 2210, 2400, 2401, 3100, 3211, 3300, 3301, 3410, 3411, 3500, 4110, 4300, 4302, 490A/B, 6 credit hours selected from courses with initial digits 42, and a selection from the remaining 4000-level courses.
2. Physics 1050 (or 1020 and 1021) and 1051.
3. Mathematics 1000, 1001, 2000, 2050 and Applied Mathematics 3260.
4. Biochemistry 2101

Recommended courses: Biochemistry 2100, Mathematics 2051, Physics 2820 and/or 2750.

A thesis based on a selected research topic carried out under the supervision of a member of the department is to be submitted in the final year.

Chemistry 490A/B will normally require the equivalent of 9 hours/week for 2 semesters. Registration in Chemistry 490A/B is restricted to those students who have honours standing. Evaluation of the dissertation will be pass/fail, assessed by a committee comprising the supervisor and two other faculty members.

With approval of the Heads of the Chemistry and Biochemistry Departments prior to registration, a number of courses in Biochemistry may be substituted for a like number of Chemistry courses.

Six credit hours in one language are recommended: French, German or Russian should be selected in consultation with the Department Head.

Prospective Honours students in Chemistry in their first year should take

1. Six credit hours in English.
2. Chemistry 1050 and 1051 (or 1010, 1011 and 1031) or their equivalents.
3. Physics 1050 and 1051 or 1020 and 1021.
4. Mathematics 1000 and 1001
5. Six credit hours in other courses.

Given appropriate circumstances the Honours Chemistry program may be completed in four years. Students should consult the Undergraduate Student Handbook for timetabling details.

Note: *Students completing first year requirements for any of Chemistry, Mathematics or Physics via the three course options (i.e. Chemistry 1010, 1011, 1031 (or 1800, 1200, 1001), Mathematics 1090, 1000, 1001, Physics 1020, 1021, 1051) instead of the two course options (Chemistry 1050, 1051, Mathematics 1000, 1001, Physics 1050, 1051) will require the corresponding number of extra credits to obtain an Honours degree.*

Arrangements for subsequent years will depend on the other science subjects being studied and should be made in consultation with the Head of the Department.

Note: *Certain advanced courses may only be offered in alternate years. Candidates therefore should consult the Head of the Department before registration.*

Certain of the Graduate courses may be taken in the final year of the Honours Program with the permission of the Head of the Department.

Note: *Details of Joint Honours programs with Biochemistry, Earth Sciences, Mathematics and Physics as outlined under **Joint Programs**.*

5.3.7 Course Restrictions

Credit will be given for no more than one of Chemistry 1000, 1010, 1050, 1200, 150A/B, no more than one of Chemistry 1001, 1031, 1051, 150A/B, and no more than one of Chemistry 1011, 1051, 150A/B.

5.3.8 Course List

In accordance with Senate's *Policy Regarding Inactive Courses*, the course descriptions for courses which have not been offered in the previous three academic years and which are not scheduled to be offered in the current academic year have been removed from the following listing. For information about any of these inactive courses, please contact the Head of the Department.

Note: *Attendance for all Chemistry Laboratory sessions is mandatory. Failure to attend may result in a failing grade or deregistration from the course.*

1010 and 1011 Introductory Chemistry I and II examines descriptive chemistry; atomic structure; chemical bonding; periodicity illustrated by the chemistry of selected elements; mole concept and stoichiometry; physical properties of matter; energetics; rates of reaction; chemical equilibrium; electrochemistry.

Prerequisite: Chemistry 1010 is a prerequisite for Chemistry 1011.

Lectures: Four hours per week.

Laboratory: Three hours per week.

1031 Introductory Chemistry III (F) & (I) prepares students who have completed Chemistry 1010 and 1011 for Chemistry 2210, 2300 and 2400. It augments the topics covered in Chemistry 1010 and 1011 with the greater depth and problem solving emphasis of Chemistry 1050 and 1051.

Prerequisites: Chemistry 1011 and Mathematics 1000.

Lectures: Four hours per week.

Laboratory: Three hours per week.

1050 and 1051 General Chemistry I and II has topics that will be similar to 1010/1011 but will be treated in greater depth with an emphasis on problem solving.

Prerequisites: Mathematics 1000. Mathematics 1000 may be taken concurrently with Chemistry 1050. Chemistry 1050 and Mathematics 1000 are prerequisites for Chemistry 1051.

Lectures: Four hours per week.

Laboratory: Three hours per week.

Notes: 1. *For entry to Chemistry 1050 students must have*

a. *achieved at least 75% in high school Chemistry 3202 and*
b. *successfully completed high school Advanced Mathematics 3205.*

2. *Other students, including those with no high school chemistry background, will take Chemistry 1010. It is recommended that students taking Chemistry 1010 have at least 70% in high school Academic Mathematics 3204, or a pass in any university level mathematics course.*

3. *Only six science credit hours will be awarded for a major or honours in Chemistry from the following course groups: Chemistry 1010/1011/1031, or Chemistry 1800/1200/1001 (Sir Wilfred Grenfell College).*

2210 Introductory Inorganic Chemistry (W) studies the chemistry of selected s, p, and d block elements. Introduction to crystal and molecular structures and to molecular orbital and crystal field theories.

Prerequisites: Chemistry 1051 (or 1001 or 1031), Mathematics 1000.

Lectures: Three per week.

Laboratory: Three hours per week.

2300 Introductory Physical Chemistry (F) & (W) examines introductory chemical thermodynamics and equilibria. Complementary laboratory work with an emphasis on quantitative analysis.

Prerequisites: Chemistry 1051 (or 1001 or 1031), Mathematics 1001, Physics 1051 or 1021.

Lectures: Three per week.

Laboratory: Three hours per week.

2400 Introductory Organic Chemistry I (F) is a course on bonding involving carbon; conformations and stereochemistry; introduction to functional groups and nomenclature; properties, syntheses and reactions of hydrocarbons, alkyl halides and alcohols.

Prerequisite: Chemistry 1051 or 1031; or Chemistry 1010 and 1011 with a grade of at least 80% in each; or Chemistry 1011 with a grade of at least 85%; or Chemistry 1001 with a grade of at least 65%.

Lectures: Three per week.

Laboratory: Three hours per week.

Note: *Credit will not be given for more than one of Chemistry 2400, 2420, 2440 and 240A/B.*

2401 Introductory Organic Chemistry II (W) is an introduction to the interpretation of infrared, H and C-13 NMR spectra; properties, syntheses and reactions of ethers, simple aromatic compounds, ketones, aldehydes, amines, carboxylic acids and their derivatives; aldol and related reactions.

Prerequisite: Chemistry 2400.

Lectures: Three per week.

Laboratory: Three hours per week.

Note: *Credit will not be given for more than one of Chemistry 2401, 2420, 2440, and 240A/B.*

2440 Organic Chemistry for Biologists (F) & (W) is an introduction to the principles of organic chemistry with an emphasis on material relevant to biological molecules. The laboratory will introduce techniques and illustrate concepts covered in the course.

Prerequisite: Chemistry 1011 (or 1001 or 1051).

Lectures: Three per week.

Laboratory: Three hours per week.

Note: *This course is designed primarily for Biology Majors. It may not be used for credit by Chemistry or Biochemistry Majors and may not serve as a prerequisite for any other Chemistry course. Credit may be obtained for only one of Chemistry 2400, 2420, 2440, 240A/B.*

3100 Analytical Chemistry I (F) & (W) is a treatment of data, gravimetric analysis, volumetric analysis including oxidation-reduction titrations using electrochemical techniques, the use of specific ion electrodes, and titrations in non-aqueous systems. Spectrophotometric trace analysis and titration.

Prerequisites: Chemistry 2300.

Lectures and Laboratories: Not more than seven hours per week.

3211 Inorganic Chemistry (W) is a detailed examination of the structure, bonding, and chemistry of the d block elements.

Prerequisites: Chemistry 2210 and 2300.

Lectures: Three per week.

Laboratory: Three hours per week.

3300 Physical Chemistry I (F) examines the laws of thermodynamics, calorimetry, thermochemistry, equilibrium constants. Introduction to thermodynamics of non-ideal gases. Topics will include partial molal quantities, phase equilibria, thermodynamics of solutions, activity coefficients of non-electrolytes, the Gibbs-Duhem equation.

Prerequisites: Chemistry 2300, Mathematics 2000.

Lectures: Three per week.

Laboratory: Three hours per week.

3301 Physical Chemistry II (W) examines electrical conductivity of solutions, electrochemical cells, equilibrium constants of weak electrolytes, activity coefficients of electrolytes. Elementary theoretical chemistry, introduction to quantum mechanics, statistical interpretation of thermodynamic functions of ideal gases, and kinetic theory of gases. Chemical kinetics including relaxation techniques and mass transport phenomena.

Prerequisites: Chemistry 3300 and Applied Mathematics 3260.

Lectures: Three per week.

Laboratory: Three hours per week.

3410 Bio-organic Chemistry (F) is a study of the major classes of biomolecules, their structure, function, and in vitro chemistry. An introduction to natural products. Synthetic polymers compared to biopolymers. Heteroaromatic molecules and derived biomolecules.

Prerequisite: Chemistry 2401. It is recommended that Chemistry 3500 be taken concurrently.

Lectures: Three hours per week.

Laboratory: Three hours per week.

Note: *Students may obtain credit for only one of Chemistry 3410 and the former Chemistry 3401.*

3411 Synthetic Organic Chemistry I (W) is a survey of some important reactions used in organic synthesis, including pericyclic reactions and those based on carbocation, carbene, nitrene and carbanion intermediates. Emphasis is placed on multifunctional compounds.

Prerequisite: Chemistry 3410, or all of Chemistry 2401, Biochemistry 2100 and Biochemistry 2101.

Lectures: Three hours per week.

Laboratory: Three hours per week.

Note: *Students may obtain credit for only one of Chemistry 3411 and the former Chemistry 3400.*

3500 Spectroscopic Analysis: Spectroscopy and Structure (F) is the application of spectroscopic methods to the determination of molecular structure. Emphasis will be placed on electronic, vibrational and rotational spectroscopy, nuclear magnetic resonance spectroscopy and mass spectrometry.

Prerequisites: Chemistry 2210, 2300, 2401. Physics 2750 is strongly recommended.

Lectures and Laboratory: Not more than six hours per week.

3600 Marine Chemistry (W) - inactive course.

4110 Analytical Chemistry II (F) examines error treatment, atomic emission and absorption spectroscopy, chromatographic and other separation techniques, electroanalytical chemistry, mass spectrometry, x-ray spectroscopy, ion and electron spectroscopy.

Prerequisites: Chemistry 3100 and 3300. Chemistry 3300 may be taken concurrently with Chemistry 4110.

Lectures and Laboratories: Not more than six hours per week.

Note: *Students may obtain credit for only one of Chemistry 4110 and the former Chemistry 4100 and for only one of Chemistry 4110 and the former Chemistry 4101.*

4150 Advanced Spectrometric Techniques - inactive course.

4151 Analytical Separations and Organic Mass Spectrometry examines advances in the traditional chromatographic techniques, the development of new analytical tools in separation science, the interfacing of mass spectrometers to chromatographic instruments, and other mass spectrometric techniques.

Prerequisites: Chemistry 4110, which may be taken concurrently (or Chemistry 4100 or Chemistry 4101)

Lectures and Laboratories: Not more than six hours per week.

4152 Electroanalytical Techniques examines the principles and theory of dynamic electrochemistry, voltammetry, stripping analysis, electro-chemical sensors and detectors.

Prerequisites: Chemistry 4110, which may be taken concurrently (or Chemistry 4100 or Chemistry 4101).

Lectures and Laboratories: Not more than six hours per week.

4201 Coordination Chemistry in Biological Molecules - Structural, Mechanistic and Magnetic Studies examines the role of certain transition elements e.g. iron, copper, cobalt, and zinc, in proteins and enzymes will be discussed in terms of structural features, the natural ligands, magnetic properties, mechanisms, etc., and reinforced with examples of 'model compounds'. Magnetic theory, in particular for polynuclear transition metal complexes, will also be developed.

Prerequisite: Chemistry 3211.

Lectures: Three per week.

4202 Selected Topics in Main Group Chemistry - inactive course.

4203 Organometallic Chemistry - inactive course.

4204 Inorganic Reaction Mechanisms and Catalysis is a survey of inorganic and organometallic reactions, their mechanisms and kinetic characteristics. In addition, stereochemical non-rigidity, reactions of coordinated ligands and homogeneous catalysis are discussed.

Prerequisite: Chemistry 3211.

Lectures: Three per week.

4205 Photochemistry of Transition Metal Complexes is an introduction to the theory of electronic excited states in transition metal complexes. Applications to artificial photosynthesis, photodynamic therapy, molecular photovoltaics and molecular electronics.

Prerequisites: Chemistry 3211 and 3301 (which may be taken concurrently).

Lectures: 3 hours per week.

4300 Advanced Physical Chemistry I: Quantum Mechanics and

Spectroscopy (F) examines solutions of the Schrodinger wave equation by means of second order differential equations and operator and matrix methods. Electronic spectra of atoms, and the rotational, vibrational and electronic spectra of diatomic and triatomic molecules. Chemical bonding.

Prerequisite: Chemistry 3301.

Lectures: Three per week.

Laboratory: Three hours per week.

4302 Statistical Thermodynamic (W) examines probability theory, ensembles, quantum statistical thermodynamics of ideal gases, perfect crystals, metals and radiation. Semiclassical statistical thermodynamics, distribution functions, dense gases and liquids.

Prerequisite: Chemistry 4300.

Lectures: Three hours per week.

Laboratory: Three hours per week.

Note: *Students may obtain credit for only one of the former Chemistry 4301 and Chemistry 4302.*

4350 Advanced Physical Chemistry III: Selected Topics in Physical Chemistry (W) - inactive course.

4411 Topics in Medicinal Chemistry - inactive course.

4420 Physical Organic Chemistry (F) is an introduction to the quantitative and qualitative theories of reactions and reactivity and their application to organic reaction mechanisms and to mechanism elucidation.

Prerequisite: Chemistry 3301, and 3401 or 3411. Chemistry 3500 is strongly recommended.

Note: *Students may obtain credit for only one of Chemistry 4420 and the former Chemistry 4400 and for only one of Chemistry 4420 and the former Chemistry 4401.*

4430 Synthetic Organic Chemistry II (W) examines modern synthetic methods with particular attention placed on the synthesis of enantiomerically enriched compounds and newer methods for the formation of carbon-carbon bonds. Designing syntheses of complex organic molecules.

Prerequisite: Chemistry 3401 or 3411. Chemistry 4420 is strongly recommended.

Note: *Students may obtain credit for only one of Chemistry 4430 and the former Chemistry 4410.*

490A/B Honours Thesis

5.4 Computer Science

5.4.1 Programs in Computer Science

The following undergraduate programs are available in the Department:

1. Major in Computer Science
2. Honours in Computer Science
3. Honours in Computer Science (Software Engineering) (B.Sc. only)
4. Computer Internship Option (CIIO) (B.Sc. and B.Sc. Honours only)
5. Minor in Computer Science
6. Applied Mathematics/Computer Science Joint Major (B.Sc. only)
7. Computer Science/Statistics Joint Major (B.Sc. only)
8. Computer Science/Pure Mathematics Joint Major (B.Sc. only)
9. Computer Science/Geography Joint Major (B.Sc. only)
10. Computer Science/Physics Joint Major
11. Computer Science/Pure Mathematics Joint Honours (B.Sc. only)
12. Computer Science/Statistics Joint Honours
13. Computer Science/Geography Joint Honours (B.Sc. only)
14. Computer Science/Physics Joint Honours
15. Joint Degree of Bachelor of Science with a Major in Computer Science and Bachelor of Commerce (Co-operative)
16. Computer Science/Economics Joint Major (B.Sc. Only)

Details of our joint program offerings in the Faculties of Arts, Science, and Business Administration may be found under the heading **Joint Programs** following the heading **Regulations for the Honours Degree of Bachelor of Science**.

5.4.2 Major in Computer Science

1. Forty-five credit hours in Computer Science courses are required for a major in Computer Science:
 - a. Computer Science 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3754, and 4770.
 - b. At least 6 additional credit hours at the 4000 level in Computer Science courses.
 - c. Three additional credit hours in Computer Science courses at the 3000 level or beyond.
2. Additional courses required of the Majors are: Mathematics 2000, 2050, Statistics 2510, and Pure Mathematics 2320.

Note: *Students are encouraged to take Business 2000, Mathematics 3000, and Statistics 2560.*

5.4.3 Honours in Computer Science

1. See General Regulations for the Honours Degree (B.A. or B.Sc. as appropriate).

2. Sixty-three credit hours in Computer Science courses are required for the Honours Degree in Computer Science, including:
 - a. Computer Science 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3719, 3724, 3725, 3754, 4770, and 4780.
 - b. Eighteen additional credit hours in Computer Science at the 4000 level.
 - c. Six additional credit hours in Computer Science courses at the 3000 level or beyond.
3. Additional courses required are: Mathematics 2000, 2050, Statistics 2510 and Pure Mathematics 2320.

Note: *Students are encouraged to take Business 2000, Mathematics 3000, and Statistics 2560.*

5.4.4 Honours in Computer Science (Software Engineering) (B.Sc. Only)

Completion of the Honours in Computer Science (Software Engineering) Program does not qualify persons to hold the designation "Professional Engineer" as defined by various Provincial Acts governing the Engineering Profession.

1. See General regulations for the Honours Degree (B.Sc.).
2. Sixty-three credit hours in Computer Science courses are required for the Honours Degree in Computer Science (Software Engineering), including:
 - a. Computer Science 1710, 2710, 2711, 2742, 2760, 3715, 3716, 3718, 3719, 3724, 3725, 3754, 4719, 4759, 4770, and 4780.
 - b. Twelve additional credit hours in Computer Science courses at the 4000 level.
 - c. Three additional credit hours in Computer Science courses at the 3000 level or beyond.
3. Additional courses required are: Mathematics 2000, 2050, Statistics 2510, and Pure Mathematics 2320.

Note: *The Honours project (4780) must be in the area of Software Engineering.*

5.4.5 Computer Industry Internship Option (CIIO):

The Computer Industry Internship Option (CIIO) provides an opportunity for qualified students to obtain rewarding placements that help them develop practical skills in a real work setting before graduation. The CIIO is available to Computer Science Majors (B.Sc. and B.Sc. Honours only) who will typically apply between their third and fourth year of studies.

Admission Requirements:

In order to be considered for admission to the CIIO, an applicant must:

1. be a declared Computer Science Major;
2. have successfully completed Computer Science 1710, Computer Science 2710, Computer Science 2711, Computer Science 2742, Computer Science 2760, Computer Science 3716, and any two other core 3000-level computer science courses; and
3. have at least one computer science course left to complete after the internship.

In addition to meeting the above applicants are also subject to academic performance.

Internship Duration:

Subject to the availability of job openings, a student may choose either an 8, 12 or 16 consecutive month internship period.

Internship Guidelines:

1. Internship employment is normally organized by the Internship Co-ordinator (hereafter referred to as the Co-ordinator); however, students who have been accepted to the CIIO may also obtain their own internship placements. All placements are subject to the approval of the Co-ordinator and of the Head of the Department of Computer Science.
2. Students who have applied to the internship program give permission to the Co-ordinator to supply prospective employers with copies of their resume.
3. After being placed with an employer, students are not permitted to drop their internship without prior approval from the Co-ordinator and the Head of the Department of Computer Science. Students who drop an internship without permission, who fail to honour an agreement to work with an employer, or who conduct themselves in such a manner as to cause their discharge from the placements, will normally be awarded a fail grade for the internship period and may not be permitted to reapply.

Note: *Students should also refer to the UNIVERSITY REGULATIONS - General Academic Regulations (Undergraduate).*

Expectation of Work:

Within a month of starting the internship, students are required to submit a plan of intended work for the internship. They are also required to submit a progress report due the last day of classes of each semester in which they are working. The plan of intended work and progress reports are to be submitted to the Co-ordinator.

At the end of the internship period, students are required to submit a final report which will include a description of their internship projects and activities as well as their original objectives and accomplishments. The final report is to be submitted to the Co-ordinator by the last day of classes of the semester in question.

Registration, Assessment of Performance, and Assignment of Grades:

Students must register for the course Computer Science 3700 every semester during their internship.

Computer Science 3700 is a non-credit course open only to students who have been accepted into the Internship Program.

During the internship, the employer and intern will complete student performance evaluations every four months and will submit them to the Co-ordinator. The final assessment of total work performed is the responsibility of the Co-ordinator, and will be based upon both input from the employer and the intern's final report.

At the end of the internship, each intern will be assigned one of the following grades after the final assessment of their performance:

1. Pass with Distinction (PWD): Indicates excellent performance in both the work report and work performance.
2. Pass (PAS): Indicates that performance meets expectations in both the work report and the work performance.
3. Fail (FAL): Indicates failing performance in the work report or the work performance.

Also, the following will be noted in the transcript of the intern:

1. Requirements for the Computer Industry Internship Option have been completed. Internship Duration: - months.
2. A grade of NC (No Credit) for Computer Science 3700 will be awarded in all semesters of the Internship Option prior to the final Semester.

CIIO and Honours Program:

In case a student is enrolled in both the Honours program and the CIIO, the requirements of both must be met. Upon approval from the

honours project supervisor, within the Department, the employer and the Head of the Department of Computer Science, an internship project may be submitted as a component of an honours project. These arrangements must be made within the first semester of the Internship placement.

5.4.6 Minor in Computer Science

1. For a Minor in Computer Science, a student must complete at least 24 credit hours in Computer Science courses, including: Computer Science 1710, 2710, 2711, 2742, 2760.
2. The remaining 9 credit hours in Computer Science courses must be at the 3000 level or above.

5.4.7 Course Numbering Scheme

There are five areas of Computer Science offered in the 3000- and 4000-level courses. The meaning of the third digit of a course number is as follows:

1- Programming Languages

2- Computer Systems

3- Numerical Computations

4- Theoretical Aspects

5,6- Applications (e.g. Artificial Intelligence, Computer Graphics, Data Base, Robotics, Computational Geometry, Image Processing, Computer Networking, Computer Aided Design)

7 - Project Course

8- Honours Project

9- Directed Readings

5.4.8 Supplementary Examinations

Supplementary examinations will be allowed in certain Computer Science courses which have written final examinations. Students should refer to the Faculty of Science degree regulations for details.

5.4.9 Faculty Advisors

The Department has an Undergraduate Advisor for Computer Science majors to consult with on academic matters.

5.4.10 Undergraduate Handbook

Additional information about the undergraduate Computer Science programs and courses can be found in the Computer Science Undergraduate Handbook available from the General Office, Department of Computer Science.

5.4.11 Course List

In accordance with Senate's *Policy Regarding Inactive Courses*, the course descriptions for courses which have not been offered in the previous three academic years and which are not scheduled to be offered in the current academic year have been removed from the following listing. For information about any of these inactive courses, please contact the Head of the Department.

5.4.11.1 First Year Courses

1510 An Introduction to Programming for Scientific Computing (F) & (W) introduces students to basic programming in the context of numerical methods with the goal of providing the foundation necessary to handle larger scientific programming projects. Numerical methods to solve selected problems from Physics, Chemistry, and Mathematics will be covered.

Lectures: Three hours per week.

Laboratory: Two hours per week.

Prerequisite: Mathematics 1000.

Notes: 1. *Students can receive credit for only one of Computer Science 1510 or Computer Science 2602.*

2. *Students who have received credit for the former Applied Mathematics 2120 cannot receive credit for Computer Science 1510.*

1600 Basic Computing and Information Technology (F) & (W) offers an overview of computers and information technology. It provides students with the knowledge necessary to answer questions, such as: What is a computer system? How does it work? How is it used? This is done through the use of popular spreadsheet, word processing and database software packages and the Internet. Social issues and implications will also be included.

Prerequisite: Level III Advanced Mathematics or Mathematics 1090, which can be taken concurrently.

Lectures: Three hours per week.

Laboratory: Three hours per week.

Note: *Students can receive credit for only one of Computer Science 1600, Computer Science 2650, Computer Science 2801, or Business 2700.*

1700 Introduction to Computer Science (F) & (W) lays the foundation for the art and the science of computing. The course contains fundamental and topical issues in computers, languages, programming and applications. This course is designed for potential Computer Science majors without a background in programming, but is also available for non majors.

Prerequisite/Co-requisite: Mathematics 1090 (or equivalent), or Mathematics 1000.

Lectures: Three hours per week.

Laboratory: Three hours per week.

1710 Object-Oriented Programming I (F) & (W) is an introduction to fundamental programming techniques, primitive data types and operations, program control structures and the use of objects, classes and methods.

Prerequisites: Mathematics 1000 (which can be taken concurrently), or Mathematics 1090 (or equivalent).

Lectures: Three hours per week.

Laboratory: Three hours per week.

Note: *Students who have previously completed Computer Science 2710 will not be permitted to register or receive credit for Computer Science 1710.*

5.4.11.2 Second Year Courses

2500 Data Analysis with Scripting Languages (F) & (W) introduces the use of scripting languages to solve common data analysis tasks. The control structures and expressions of the language are first discussed. Script solution to storing/retrieving data sets, searching data sets, and performing numeric and statistical calculation are covered. Plotting and visualization for data sets are also presented.

Prerequisite: Computer Science 1510 or Computer Science 1700 or Computer Science 1710 or Computer Science 2602 (or equivalent).

2602 Computer Programming in FORTRAN (F) is a study of algorithmic problem solving and structured programming techniques; the Fortran programming language and its application to computer solutions of scientific problems; numeric and non-numeric problems are examined with emphasis on code modularity and reusability of the components.

Prerequisite: Mathematics 1000.

Note: *Students who have received credit for the former Computer Science 2600, or the former 2601, or the former 2800 cannot receive credit for Computer Science 2602.*

2650 Problem-Solving with Personal Computers (F) & (W) is an overview of tools and techniques that current computer technology offers in a PC based networked environment. The emphases are on conceptual understanding of the software, from exploring capabilities of the existing software tools to learning methods of extending these capabilities. The key topics include problem-solving strategies, visual programming, macro-language operations, object linking and embedding, digital communication, and developing interactive web pages. The course has a practical flavour. In structured laboratory sessions, students gain proficiency in using personal computers for solving common problems.

Prerequisite: Level III Advanced Mathematics or Mathematics 1000 (which can be taken concurrently) or Mathematics 1090 (or equivalent).

Note: *Students can receive credit for only one of Computer Science 1600, Computer Science 2650, Computer Science 2801, or Business 2700.*

2710 Object-Oriented Programming II (F) & (W) continues from Object-

Oriented Programming I, and studies object-oriented and event-driven programming. Additional topics include: recursion, basic analysis of algorithms, fundamental data structures such as simple linked structures and stacks, and fundamental computing algorithms such as binary search and quadratic time sorting. A brief overview of programming languages, virtual machines and language translations is also provided.
Lectures: Three hours per week.
Laboratory: Three hours per week.
Prerequisite: Computer Science 1710.

2711 Introduction to Algorithms and Data Structures (F) & (W) includes the study of standard ways of organizing and manipulating data in computer storage. Fundamental concepts in the design and analysis of algorithms are also discussed.
Lectures: Three hours per week.
Laboratory: Three hours per week.
Prerequisite: Computer Science 2710.
Note: *It is recommended that students complete Computer Science 2742 prior to registering for Computer Science 2711.*

2742 Logic for Computer Science (F) & (W) is an introduction to propositional and predicate logic with applications. The use of the system of boolean logic in reasoning and circuit design, as well as basic proof techniques and the resolution principle, for both propositional and predicate logic, will be covered. Concepts involving sets will be used to illustrate different types of proof techniques. The probable intractability of boolean logic and Goedel's incompleteness theorem will be presented.
Prerequisite: Computer Science 1710.

2752 Introduction to Business Data Processing (F) - inactive course.

2760 Encountering the Computer: Society and the Individual (F) & (W) examines social, ethical, legal and cultural issues surrounding the use of computers in modern society. These broader social issues are followed by an examination of the use of social and individual psychology in user interface design. Students will be expected to demonstrate an understanding of these issues both directly (through verbal and written discourse) and practically, as applied to the creation of actual software artifacts.
Prerequisites: Two 1000-level English courses, or equivalent.
Co-requisite: Computer Science 2710.

2801 Introductory Computing for Business (F) & (W) introduces students to computer applications in business, document processing, application development, decision support, and information management. A three hour laboratory is required.
Prerequisite: Level III Advanced Mathematics or Mathematics 1000 (which can be taken concurrently) or Mathematics 1090 (or equivalent).
Note: *Students can receive credit for only one of Computer Science 1600, Computer Science 2650, Computer Science 2801, or Business 2700.*

5.4.11.3 Third Year Courses

3700 Industrial Experience (F), (W), (S) is a course for students who are admitted to CIO. Students are required to register for this non-credit course every semester during their internship. This course is open only to students who have been accepted into the Internship Program and provides an opportunity for qualified students to obtain rewarding job experience of 8, 12 or 16 months of continuous duration, during the course of their studies.
Prerequisite: Admission to the Computer Industry Internship Option (CIIO).

3710 Vocational Languages (W) is a study of several programming languages of vocational significance (e.g. a selection from C, C++, Prolog, Perl, Python and LISP). The use of appropriate programming paradigms to solve some significant problems.
Prerequisite: Computer Science 2711.

3714 Programming Languages and their Processors (F) & (W) reviews typical elements of (imperative) programming languages, and then discusses language implementations in the form of compilers and interpreters. The topics include specification of syntax and semantics of programming languages, discussion of expressions and assignments, side effects, control structures, data and procedural abstractions, parameter passing mechanisms, bindings, scopes, and type systems. The recursive-descent technique is used for illustrations of different aspects of syntax analysis, code generation and error recovery. Language interpreters are discussed for both low-level and high-level languages.
Prerequisites: Computer Science 3719 and 3724.

3715 Network Computing with WEB Applications (F) & (W) studies how distributed applications (e.g., client/server Web applications) are constructed using the Internet. Topics covered include: the socket interface for network communication, client/server applications, browser scripting using Javascript, content generation for web applications (e.g., jsp, php), html/css documents, and the use of cryptography to handle security.
Prerequisite: Computer Science 2711.

3716 Software Methodology (F) & (W) studies the development of software by gathering the requirements of the software program, analyzing the requirements to create a development model, and creating the software and documents for the software product. This course studies techniques for all three software development activities.
Prerequisite: Computer Science 2711.

3717 Symbolic Computation and Recursion (W) - inactive course.

3718 Programming in the Small (F) demonstrates the tools and techniques

used in the construction of small software systems. The software tools and techniques to be covered include analysis and design of software components, software construction tools (e.g. linkers, builders, debuggers), software library use and design, and system integration.
Prerequisites: Computer Science 2711 and Pure Mathematics 2320.

3719 Theory of Computation and Algorithms (F) & (W) is an introduction to formal algorithmic problem solving. Various algorithm design techniques that sometimes yield efficient solutions are studied. Deterministic and nondeterministic machines (finite state automata, pushdown automata and Turing machines) are discussed and used to efficiently solve problems such as the String Matching Problem, the parsing of Context-free Languages, and to introduce the theory of NP-completeness. In addition, Turing machines are used to prove the unsolvability of certain problems. Tractable, intractable and undecidable problems are contrasted. Basic issues related to parallelization are discussed as well.
Prerequisites: Computer Science 2711 and Pure Mathematics 2320.
Note: *Credit cannot be obtained for both Computer Science 3719 and the former Computer Science 3711. Credit cannot be obtained for both Computer Science 3719 and the former Computer Science 3740.*

3723 Logic Design (F) - inactive course.

3724 Computer Organization (F) & (W) can be studied at the digital logic implementation level, the instruction set architecture level, and the translation of programming languages to the underlying machine instruction level. This course studies computer organization at these levels.
Prerequisites: Computer Science 2711 and Computer Science 2742.
Co-requisite: Pure Mathematics 2320.

3725 Computer Architecture and Operating Systems (F) & (W) covers system design and the architectural implementations of these designs. The objective is to develop the basic concepts of processor design, memory management, operating systems, and I/O devices and their interactions.
Prerequisite: Computer Science 3724.

3731 Introduction to Scientific Computing (W) main objectives are the development of algorithms for the numerical solution of mathematical problems and the study of the numerical stability of these algorithms. The efficiency of these algorithms with respect to speed and storage requirements is considered as well. Emphasis is also placed on the study of the sensitivity of selected problems to perturbations in the data. There is also a brief introduction to the development of numerical algorithms that take advantage of advanced computer architectures, such as pipeline processors, array processors and parallel processors.
Prerequisites: Mathematics 2000 and Mathematics 2050, and one of Computer Science 2602 or Computer Science 2710.
Note: *Credit cannot be obtained for both Computer Science 3731 and Applied Mathematics 3132.*

3751 Computational Aspects of Operations Research (W) - inactive course.

3753 Computational Aspects of Linear Programming (F) is an introduction to the Linear Programming Problem (LPP). The emphasis is placed upon developing the most recent and numerically reliable algorithms for the solution of the Linear Programming Problem. The numerical stability of these algorithms will be examined as well. Geometric understanding of the LPP. Simplex method for the LPP. Sparse matrix LPP. Duality and postoptimality analysis. Extensions to the simplex algorithm. Principles of interior algorithms for the LPP.
Prerequisite: Mathematics 2050, and one of Computer Science 2602 or 2710.

3754 Introduction to Information and Intelligent Systems (F) & (W) introduces students to application areas that are away from usual number-based and text-based processing. Students will learn the basic concepts and become aware of the historical developments and social and ethical issues related to the application areas such as intelligent systems and information management. This exposure will help students to become knowledgeable about managing large volumes of data and dealing with problems that are well defined but whose algorithmic solutions are not feasible or problems that are fuzzily defined.
Prerequisites: Computer Science 2711 and Computer Science 2742.

3790 Directed Readings - inactive course.

5.4.11.4 Fourth Year Courses

4711 Structure of Programming Languages (F) covers programming language design considerations; syntactic and semantic structure; survey of typical features and operations; analysis of facilities for control and data structuring; language extensibility; execution models; formal specification of programming languages.
Prerequisites: Computer Science 3719 and Computer Science 3724.

4712 Compiler Construction (W) studies properties of formal grammars and languages; syntax-directed parsing and code generation; top-down and bottom-up parsing methods; LL(k) and LR(k) grammars and parsers; Code optimization; compiler writing tools.
Prerequisites: Computer Science 3719 and Computer Science 3724.

4715 and 4717 Special Topics in Programming Languages

4718 Survey of Software Engineering (F) surveys the major topics of software engineering. Areas covered include: requirements capture, system

design and design approaches, verification and validation (including formal methods and testing), and management of the software development process.

Prerequisite: Computer Science 3716.

4719 Software Specification (F) - inactive course.

4721 Operating Systems (W) studies the design and implementation of an operating system's kernel. The main components used in operating system implementations include: context switches, process management, memory management, interprocess communication, file systems and system calls. The data structures and algorithms used in implementing the above components are studied. The different architectural styles of kernel implementation are also considered. Real-time operating systems are also discussed.

Prerequisite: Computer Science 3725.

4723 Introduction to Microprocessors (F) examines the architecture and instruction sets for several microprocessors. The use of microprocessors as device controllers; comparisons of hardware and programmed techniques; microprocessor interfacing with external devices; methods of I/O; bus structures; modern microprocessor support devices are discussed.

Prerequisite: Computer Science 3724.

Lecture: Three hours per week.

Laboratory: Minimum of three hours per week. Practical experience with basic principles will be obtained through laboratory experience.

4725 Introduction to LSI Design (W) - inactive course.

4726-4729 Special Topics in Computer Systems

4734 Matrix Computations and Applications (W) is an introduction to linear algebra; solution to linear systems; scaling, improving and estimating accuracy; the linear least squares problem; the eigenvalue problem; singular value decomposition of a matrix; the generalized eigenvalue problem.

Prerequisite: Computer Science 3731.

4735 Advanced Matrix Computations and Applications (F) - inactive course.

4736-4739 Special Topics in Numerical Computations

4740 Design and Analysis of Algorithms (W) will give an overview of techniques for the design of efficient optimal-solution and heuristic algorithms. It will include an introduction to various advanced data structures for set and string processing that are used to further optimize algorithm efficiency.

Prerequisite: Computer Science 3719.

4741 Formal Languages and Computability (F) is an in-depth study of various types of formal machines and their associated languages. Effective computability and other formalisms, such as lambda calculus will be studied as well.

Prerequisite: Computer Science 3719.

Note: *Students can receive credit for only one of the former Computer Science 3740 or Computer Science 4741.*

4742 Computational Complexity (F) is an in-depth discussion of computational complexity theory. Topics covered in the course include: models of computation (for both serial and parallel computations); complexity measures; reducibility; complexity classes (NP, PSPACE, NC, LOGSPACE and P); and randomized computations.

Prerequisite: Computer Science 3719.

4743 Graph Algorithms and Combinatorial Optimization (W) discusses classical problems in combinatorial optimization and graph algorithms, including matching, colorability, independent sets, isomorphism, network flows and scheduling. Special families of graphs are discussed and algorithms that would otherwise be NP-hard or complete are shown to be polynomial time when restricted to such families.

Prerequisite: Computer Science 3719.

4745-4749 (Excluding 4748) Special Topics in Theoretical Aspects

4748 Introduction to the Science of Complexity (F) is an exploration of the use of computers in the simulation of complex systems. Some theories and models, such as cellular automata, artificial life, fractals, genetic algorithms, chaos, and evolution will be discussed and will be used in the modelling of "real-life" systems. The approach in this course is practical. Students have to write a number of programs of different levels of sophistication including a final project.

Prerequisite: Computer Science 3719.

4751 Computer Graphics (F) examines display devices, display

processors, display file compilers, display transformations, structured display files, graphical input devices, perspective, hidden line elimination, languages and graphics systems.

In addition to three one-hour lectures, there will be a minimum three hour laboratory per week, to be scheduled by the Department.

Prerequisites: Computer Science 3719 and Mathematics 2050.

4753 Artificial Intelligence (F) has selected topics from AI programming languages; heuristic searching; problem solving; game-playing; knowledge representations; knowledge-based systems; reasoning in uncertainty situations; planning; natural language understanding; pattern recognition; computer vision; and machine learning.

Prerequisites: Computer Science 3719 and 3754.

4754 Database Systems (F) introduces students to database processing, database management systems and database design considerations. It will cover the theory and methodologies essential for the relational database design, implementation, manipulation, optimization and management.

Prerequisites: Computer Science 3725 and 3754.

4759-4769 (Excluding 4756, 4759, 4761 and 4762) Special Topics in Applications

4756 Image Processing (W) will centre on the key analytical and algorithmic tools and concepts of digital image processing. Topics will include Transformations, Enhancement, Encoding, Data Bases, Segmentation and Description.

In addition to three one-hour lectures, there will be a three hour laboratory per week, to be scheduled by the Department.

Prerequisite: Computer Science 3719.

4759 Computer Networks (W) looks at how the operation of computer networks requires the following: a) communication between two computers, b) information transfer between two computers not directly connected, and c) services that need computer communication. This course focuses on the standard solutions and services used to fulfill the previous requirements. These include: physical transmission of signals, reliable communication based on unreliable communication channels, the routing of messages between connected computers to reach computers that are not directly connected, e-mail, file transfer, name servers, remote terminal access and the World Wide Web. Particular attention will be placed on the workings of the Internet.

Prerequisites: Computer Science 3715 and Computer Science 3725.

4761 Human-Computer Interaction (W) emphasizes user-interface design, distinguishing usability research from testing. Students identify usability issues, and then prototype and analyze their own solutions. Representative methods, techniques and tools related to design, testing and research are discussed. Specific topics may include: environments and toolkits, task analysis, user modeling, user psychology, qualitative and quantitative data analysis.

Prerequisites: Computer Science 2760 and 3719 and Statistics 2510.

4762 Introduction to Computational Molecular Biology (W) will give an overview of computational problems and algorithms for these problems associated with a variety of analyses of biological molecular data.

Prerequisite: Computer Science 3719.

4770 Team Project (F) & (W) has as its main objective to develop a working prototype of a software system as a team effort. A group of students will work on a project for a term, experiencing the advantages and difficulties of team projects.

Prerequisite: Computer Science 3716.

4780 Honours Project introduces computer science honours students to research activities, familiarizes them with a special problem in computer science, and provides independent study on an advanced topic under the direct supervision of a member of the computer science faculty. The topic is decided in consultation with the supervisor. The student is required to produce a written report on the project, to include the literature search on the topic, and to present this work at a departmental seminar prior to the last week of the semester.

Prerequisite: Consent of the Head of Department.

Note: *This course is only available to students who have been accepted into the honours program.*

4800-4825 Special Topics will be offered as departmental resources permit.

Prerequisites/Co-requisites: Special topics courses are not offered on a regular basis, but whenever departmental resources permit. For these reasons, the prerequisites can vary each time the courses are offered.

5.5 Earth Sciences

5.5.1 Programs in Earth Sciences

The following undergraduate programs are available:

120 credit hour programs

1. Honours or General degrees in Earth Sciences
2. Joint Honours in Earth Sciences/Physics
3. Joint Honours in Geography/Earth Sciences

4. Joint Honours in Geophysics/Physical Oceanography
5. Joint Major in Earth Sciences/Physics

135 credit hour programs

1. Joint Honours in Biology and Earth Sciences
2. Joint Honours in Earth Sciences/Chemistry

24 credit hour program

1. Minor in Earth Sciences

Although Honours programs can be completed in 120 credit hours, students who do not select the prescribed common block of required courses will normally need more than 120 credit hours to satisfy degree requirements.

Details of joint programs are given after the **Regulations for the Honours Degree of Bachelor of Science**.

5.5.2 Undergraduate Handbook

Additional information about the undergraduate program, individual courses and suggested timetables can be found in the Department of Earth Sciences Undergraduate Handbook which is available on the web at www.mun.ca/earthsciences.

5.5.3 Entrance Requirements

In order to be formally admitted to major programs in Earth Sciences, students must have successfully completed 3 first-year credit hours in each of the following departments: English, Mathematics, Earth Sciences, Chemistry and Physics; these courses must be selected from the list of required courses for degree programs in Earth Sciences. Students are encouraged to declare their major in their first year of study at the university.

Most of the 2000 level Earth Sciences courses that are required for major and minor programs in Earth Sciences have Physics and Chemistry prerequisites, and students are advised to complete these prerequisites in their first year of study.

Students will not normally be permitted entry to 3000 level (or above) Earth Sciences courses without having completed all 1000-level courses listed in the **Common Block of Required Courses** specified in Clause 1. in the Major Programs in Earth Sciences.

5.5.4 Minor in Earth Sciences

A Minor in Earth Sciences will consist of the following:

1. Earth Sciences 1000, 1002, 2030, 2031, 2401 or 2702.
2. Nine credit hours chosen from Earth Sciences courses at the 2000 level or higher with at least 3 credit hours from courses at the 3000 level or higher. Credit hours from Earth Sciences 2150, 2311, 2914, 2915, 2916, 4310 and 4950 cannot be used to fulfil this requirement.

Several of the courses at 3000 level or higher have Earth Sciences 2502 and 2905 as co- or prerequisites.

5.5.5 Major Programs in Earth Sciences

Programs in Earth Sciences consist of a common block of required courses (below), and additional courses that depend on the degree being sought.

Common Block of Required Courses:

All majors in Earth Sciences must complete those courses specified in Clauses 1. through 4. Students should examine prerequisites of 3000 level courses in order to decide which course to select under Clauses 3. and 4.

1. English 1080 and 1110 (or equivalent), Mathematics 1000 and 1001, Earth Sciences 1000 and 1002, one of Chemistry 1010 or 1050 (or equivalent) and one of Chemistry 1011 or 1051 (or equivalent), Physics 1050 and 1051 or Physics 1020* and 1021*.

*Students who intend or are required to complete higher level Physics courses must complete Physics 1051 as well, since it is a prerequisite for higher level Physics courses. Students should review the Department of Physics calendar entry for these courses. Students will receive credit for only two first year Physics courses if they take Physics 1020, 1021 and 1051.

2. Earth Sciences 2030, 2031, 2401, 2502, 2702, 2905.
3. Mathematics 2000 or Statistics 2510.
4. Biology 2120 (or Biology 1001 and 1002), or Physics 2055.

Students must ensure that the prerequisites for Earth Sciences courses are fulfilled. Great difficulties in timetabling may be encountered if the required first-year courses are not completed before the beginning of second year.

5.5.6 Honours B.Sc. Degree in Earth Sciences

Geoscientific careers vary widely in required background. The Honours B.Sc. program is designed with considerable choice in order that students may personalize their programs based on career goals. Note that the flexibility afforded by this program is not without limits. Some courses have prerequisites, and it is ultimately the student's responsibility to ensure that these prerequisites are satisfied. Students should consult faculty members and the departmental Student Handbook for guidance in selecting courses appropriate to particular career paths.

In addition to the **Common Block of Required Courses** listed under **Major Programs in Earth Sciences**, the following requirements must be completed to qualify for the Honours B.Sc. degree in Earth Sciences:

1. Earth Sciences 499A and 499B.
2. At least 31 additional credit hours from Earth Sciences courses at 3000 and/or 4000 levels with a minimum of 12 credit hours from courses at the 4000 level. Credit hours from Earth Sciences 2150, 2914, 2915, 2916, 4310 and 4950 cannot be used to fulfil this requirement.
3. Six credit hours from the Faculty of Science courses numbered 2000 or higher. Credit hours from Earth Sciences courses, Biology 3811 and the former Physics 2050 are excluded.
4. Additional credit hours selected to conform with regulations for the Honours Degree of Bachelor Science so as to achieve a total of 120 credit hours. Students are encouraged to complete a minor in another department.

5.5.7 General B.Sc. Degree in Earth Sciences

In addition to the **Common Block of Required Courses** listed under **Major Programs in Earth Sciences**, the following requirements must be completed to qualify for the General B.Sc. degree in Earth Sciences:

1. Twenty-one additional credit hours from Earth Sciences courses at 3000 and/or 4000 levels with a minimum of 9 credit hours from courses at 4000 level. Credit hours from Earth Sciences 2150, 2914, 2915, 2916, 4310, 4950 and 499A/B cannot be used to fulfill this requirement.
2. Six credit hours from Science Faculty courses numbered 2000 or higher. Credit hours from Earth Sciences courses, Biology 3811 and the former Physics 2050 are excluded.
3. Additional credit hours selected to conform with regulations for the General Degree of Bachelor Science so as to achieve a total of 120 credit hours. Students are encouraged to complete a minor in another department.

Students are advised that this is the minimum requirement for the General B.Sc. in Earth Sciences. Many provinces, including Newfoundland and Labrador, have legislation requiring registration of professional geoscientists. A basic requirement for registration is, in most cases, the course equivalent of an Honours B.Sc. degree. Students intending to make a career in Earth Sciences should consider taking the Honours Degree program of courses, regardless of whether honours standing is maintained.

Table of Credit Restrictions for Present Earth Sciences Courses with Former Courses

Present	Former Equivalents	Present	Former Equivalents
Earth Science 1000	Earth Science 1010, Geology 1000, Geology 1010	Earth Science 3400	Earth Science 3120, Geology 3120
Earth Science 1001	Earth Science 1011, Geology 1001, Geology 1011	Earth Science 3611	Earth Science 4611
Earth Science 2030	Earth Science 203A, Geology 203A	Earth Science 3701	Earth Science 3070, Geology 3070
Earth Science 2031	Earth Science 203B, Geology 203B	Earth Science 3811	Earth Science 3801, Earth Science 2801, Geology 2801
Earth Science 2150	Physics 2150	Earth Science 4053	Geology 4053
Earth Science 2310	Earth Science 2300, Earth Science 2900, Geology 2900	Earth Science 4054	Earth Science 4052, Geology 4052
Earth Science 2400	Earth Science 2161, Earth Science 2070, Physics 2070	Earth Science 4160	Physics 4160
Earth Science 2401	Earth Science 3400, Earth Science 3120, Geology 3120	Earth Science 4171	Physics 4171
Earth Science 2502	Earth Science 2501, Earth Science 3200, Geology 3200	Earth Science 4179	Earth Science 4970, Physics 4970
Earth Science 2702	Earth Science 3701, Earth Science 3070, Geology 3070	Earth Science 4211	Geology 4211
Earth Science 2905	Earth Science 2310, Earth Science 2300, Earth Science 2900, Geology 2900	Earth Science 4302	Earth Science 4501, Geology 4501
Earth Science 2914	Earth Science 2414, Geology 2414	Earth Science 4310	Geology 4310
Earth Science 2915	Earth Science 2415, Geology 2415	Earth Science 4312	Earth Science 4311, Earth Science 4111
Earth Science 3053	Earth Science 3050, Earth Science 3052, Geology 3050	Earth Science 4901	Earth Science 4320, Earth Science 400A, Geology 400A
Earth Science 3054	Earth Science 2503 and Earth Science 3053	Earth Science 4400	Earth Science 4120, Geology 4120
Earth Science 3055	Earth Science 2503 and Earth Science 3053	Earth Science 4502	Earth Science 4201, Geology 4201
Earth Science 3161	Earth Science 3160, Physics 3160	Earth Science 4601	Geology 4601
Earth Science 3170	Physics 3170	Earth Science 4700	Geology 4700
Earth Science 3172	Earth Science 3171, Physics 3171	Earth Science 4800	Earth Science 4110, Geology 4110
Earth Science 3210	Geology 3210	Earth Science 499A/B	Earth Science 4991, Geology 4991

General notes for all Earth Sciences programs and courses

- Notes:
1. Students wishing to pursue study within the programs offered by Earth Sciences are strongly advised to keep in close contact with the Department to discuss course programs before registration in order to maintain proper sequencing.
 2. Students wishing to take some Earth Sciences courses without intending to major in Earth Sciences should consult with the Head of Department (or delegate) to determine the courses most suitable to their needs and capabilities. Earth Sciences 2914, 2915, 2916 and 2150 are especially suitable for such students and have no Earth Sciences prerequisites.
 3. Most courses comprise six hours of instruction per week, usually three hours of lectures or seminars and a three-hour laboratory period; however, at an advanced level other methods of instruction may be adopted.
 4. Consult the notes of field courses 2905, 3905 and 4905 for additional information. These courses require payment of a participation fee to cover costs for logistics and equipment. Registration for these courses will be by application only and may be competitive.
 5. The prerequisites for courses 4302, 4902 and 4903 refer to core courses in the Faculty of Science. For the purposes of these prerequisite statements, core courses are defined as those courses that are specified by each department as mandatory to fulfil the course requirements for their General or Honours programs.
 6. Certain of the 4000 level courses may not be offered every year.
 7. At most 6 credit hours in courses at the 1000-level can be used towards the course requirements in Earth Sciences for the Major, Minor, Joint Major, Honours or Joint Honours.

5.5.8 Course List

The first digit of each course number designates the level (year) of the course. The second digit indicates the area of Earth Sciences into which the course best fits, as follows:

Second Digit

- 0 - mineralogy and petrology
- 1 - geophysics
- 2 - economic geology
- 3 - stratigraphy and marine geology
- 4 - structural geology and tectonics
- 5 - geochemistry
- 6 - technical fields and petroleum geology
- 7 - sedimentation, geomorphology
- 8 - paleontology
- 9 - general and dissertation

In accordance with Senate's *Policy Regarding Inactive Courses*, the course descriptions for courses which have not been offered in the previous three academic years and which are not scheduled to be offered in the current academic year have been removed from the following listing. For information about any of these inactive courses, please contact the Head of the Department.

5.5.8.1 First Year

1000 Earth Systems is a survey of the structure, function and interrelations of Earth's lithosphere, hydrosphere, atmosphere and biosphere. Topics include an exploration of the physical and chemical properties of planetary materials, forces driving and sustaining Earth systems, and biological modifiers (including humankind) on the Earth today.
Lectures: Three hours per week.
Laboratories: Three hours per week.

1001 Evolution of Earth Systems - inactive course.

1002 Concepts and Methods in Earth Sciences provides an introduction to a broad range of concepts concerning the development of the geological record and the Earth; practical methods for collection of field based data; topics in map interpretation and geometric analysis, stratigraphy, paleontology, structure and petrology. The course is presented with an emphasis on the development of practical skills needed to pursue a career in Earth Sciences.
Lectures: Three hours per week.
Laboratories: Three hours per week.
Prerequisite: Earth Sciences 1000.

5.5.8.2 Second Year

2030 Mineralogy (F) provides an introduction to crystallography and the structure of minerals; introduction to crystal optics; study of the rock forming minerals and minerals of economic significance. Laboratory work comprises study of the structures and symmetries of minerals, chemistry of rock forming minerals, introduction to transmitted light microscopy of rocks, hand specimen recognition of common rocks and minerals.
Prerequisites: Earth Sciences 1000, Chemistry 1011 (or 1051 or equivalent), Physics 1051 (or 1021 or 1054), and its Mathematics prerequisite is strongly recommended.
Co-requisite: Earth Sciences 2502.
Note: See credit restriction under Earth Sciences 2031.

2031 Mineralogy and Petrography (W) examines the optical and chemical properties of rock-forming minerals, the petrography and classification of igneous and metamorphic rocks and applications of relevant phase equilibria to the study of minerals. Laboratory work comprises optical mineralogy and petrography of igneous and metamorphic rocks.
Prerequisites: Earth Sciences 2030 and 2502.
Note: Credit cannot be obtained for both Earth Sciences 203A/B and one or both of Earth Sciences 2030 and 2031.

2150 The Solar System (F) & (W) describes the basic astronomy of the Solar System, tracing the search to understand motion of the Sun, Moon and planets in the sky; modern observations of planets, moons, comets, asteroids and meteorites and what they tell us about the origin and evolution of the Solar System.
Note: Earth Sciences 2150 is designed for students taking Earth Sciences as an elective. Earth Sciences 2150 is not acceptable as one of the required courses for the Minor, Major or Honours programs in Earth Sciences.

2311 Geoscience Communication (W) - inactive course.

2400 Plate Tectonics (W) - inactive course.

2401 Structural Geology (W) provides an introduction to basic concepts; the physics of rock deformation, the classification and descriptive geometry of major and minor structures and their relationship to stress and strain. Laboratory work will concentrate on analysis of structural orientation data, and the analysis of structures in geological maps and cross-sections.
Prerequisites: Earth Sciences 2905 or permission of the Head of the Department (or Delegate) for students following a minor in Earth Sciences.
Notes: 1. Earth Sciences majors are advised to complete field course,

Earth Sciences 3905, immediately following completion of this course.

2. Credit may not be obtained for both Earth Sciences 2401, and the former Geology 3120 or Earth Sciences 3120 or Earth Sciences 3400.

2502 Introduction to Geochemistry (F) provides an overview of both low- and high-temperature geochemistry. Topics include: origin and classification of the elements; chemical differentiation of the solar system and solid Earth; aqueous geochemistry and the stability of minerals; radiogenic and stable isotopes. Geochemical concepts are illustrated using data and processes drawn from Earth systems. The laboratory component emphasizes the development of numerical skills needed in geochemistry.
Prerequisites: Earth Sciences 1000, Chemistry 1011 (or 1051 or equivalent).
Co-requisite: Mathematics 1001.

2702 Sedimentology and Stratigraphy (F) is a study of the origin and composition of sediments with a focus on depositional processes and resulting sedimentary structures. Study of environments of deposition and the stratigraphic framework of sedimentary successions. Laboratories involve local field trips and the study of hand samples of sedimentary rocks.
Prerequisite: Earth Sciences 1002.
Note: Credit may not be obtained for both Earth Sciences 2702 and the former Geology 3070 or Earth Sciences 3070 or Earth Sciences 3701.

2905 Introduction to Geological Mapping (F) is a two credit hour course based on approximately 6 days of geological mapping in Precambrian rocks near St. John's, and 2 days of in-class work preparing a digital map and written report. Emphasis is placed on the recognition and description of sedimentary and igneous rocks in the field, and techniques of geological mapping and the taking of field notes.
Prerequisite: Earth Sciences 1002.

- Notes: 1. This course will be given during a special session immediately preceding the fall semester. Entry is by application to the Head of the Department (or delegate) only.
2. Credit may not be obtained for both Earth Sciences 2905 and the former Earth Sciences 2310 or Earth Sciences 2300.
3. Attendance for all of the field school days is required. Failure to attend may result in a failing grade or withdrawal from the course.

2914 The Earth's Energy Resources: Past, Present and Future (F) (same as former Geology 2414 and Earth Sciences 2414) provides a scientific analysis of the Earth's energy resources. The history of human exploitation of them; consequences for quality of life, and political and economic power; scenarios for the future.
Note: Earth Sciences 2914 is designed for students taking Earth Sciences as an elective subject. This course complements traditional disciplines such as history, economics, and political science and should be of particular interest to teachers. Earth Sciences 2914 is not acceptable as one of the required courses for the Minor, Major or Honours programs in Earth Sciences.

2915 The Earth's Material Resources: Past, Present and Future (W) (same as former Geology 2415 and Earth Sciences 2415) provides a scientific analysis of the Earth's material resources (metals, non-metals, water). The history of human exploitation of them; consequences for quality of life, and political and economic power; scenarios for the future.
Note: Earth Sciences 2915 is designed for students taking Earth Sciences as an elective subject. This course complements traditional disciplines such as history, economics, and political science and should be of particular interest to teachers. Earth Sciences 2915 is not acceptable as one of the required courses for the Minor, Major or Honours programs in Earth Sciences.

2916 Natural Hazards on a Dynamic Earth (W) describes the surface of the Earth being in a constant state of change, thereby posing risks and challenges for society. An understanding of geological processes in the past and present provides context for evaluating risks related to earthquakes, volcanic activity and mass movements, challenges related to water resources, land-use planning and waste disposal, and the background to interpret sources and consequences of climate change. The course will provide a broad perspective on contemporary issues facing society.
Note: Earth Sciences 2916 is designed for students taking Earth Sciences as an elective subject. This course complements traditional disciplines such as history, economics, and political science and should be of particular interest to teachers. Earth Sciences 2916 is not acceptable as one of the required courses for the Minor, Major or Honours programs in Earth Sciences.

5.5.8.3 Third Year

3030 Mineralogy and Materials Science provides a review of elementary crystallography, introduction to space groups and crystal structures, bonding, properties of metals, semiconductors and insulators, crystallographic aspects of order-disorder, solid solution and mixing. Crystal growth, chemical zoning and diffusion. Phase changes in the solid state (exsolution, polymorphism and polytypism). Students will be introduced to the techniques used to study solids (X-ray diffraction, scanning and transmission electron microscopy, electron-microprobe analysis, luminescence, and computer simulation). Laboratory work will emphasize practical skills using these techniques. Examples will be chosen from among minerals, ceramics, semiconductors, metals and glass, making the course suitable for Earth Scientists, Engineers, Chemists and Physicists.

Prerequisites: Earth Sciences 2030 or equivalent; permission of instructor.

3054 High-Temperature Geochemistry and Igneous Petrology (F) is an integrated course dealing with the geochemistry, origin and classification of igneous rocks. Topics include trace element geochemistry; physical properties of magmas, physical and chemical processes in magma chambers (fractional crystallization, differentiation, assimilation and partial melting), phase equilibria and application to magmas, petrology of the mantle, and igneous rocks of specific tectonic settings (oceanic lithosphere, continental margins, continental lithosphere). Laboratories include geochemical calculations and examination of rock samples and thin sections.

Prerequisites: Earth Sciences 2031 and 2502.

Note: *Credit may not be obtained for 3054 and the combination of 3053 and the former 2503.*

3055 Thermodynamics and Metamorphic Petrology (W) is an integrated course dealing with the geochemistry, origin and classification of metamorphic rocks. Topics include thermodynamic background and kinetics (transfer of mass and energy in geochemical systems of the Earth's interior, thermodynamic laws, phase equilibria, solid-solid reactions, reaction rates); metamorphic facies, field gradients, isograds and reactions; mineral assemblages and textures of common metamorphic rocks. Laboratories include thermodynamic and phase diagram problems, hand specimen and thin section studies.

Prerequisites: Earth Sciences 2031 and 2502, Mathematics 1001.

Note: *Credit may not be obtained for 3055 and the combination of 3053 and the former 2503.*

3170 Exploration Geophysics I (W) examines fundamentals of seismic energy transmission in the Earth; basic methods in seismic exploration - data acquisition, processing and interpretation for refraction and reflection surveys; fundamentals of gravity and magnetic data acquisition, processing and interpretation; introduction to gravity and magnetic modelling. This course has a laboratory component.

Prerequisites: Mathematics 2000 or Statistics 2510.

Prerequisite or Co-requisite: Earth Sciences 2905.

3172 Exploration Geophysics II (F) is an introduction to electrical and electromagnetic methods in geophysics applied in mineral exploration, petroleum well logging and environmental studies, and examples of application of various techniques; use of data processing and modelling techniques in interpretation; introduction to radiometric methods used in mineral and petroleum exploration. This course has a laboratory component.

Prerequisites: Mathematics 2000 or Statistics 2510.

Prerequisite or Co-requisite: Earth Sciences 2905.

3179 Geophysical Analysis covers Vector Calculus; curvilinear coordinates; line, surface and volume integration; integral theorems; the derivation and application of geophysically important partial differential equations - Laplace's equation to the Earth's gravity and magnetic fields, the diffusion equation to the Earth's heat flow, and the wave equation to electromagnetic and seismological phenomena; geophysical uses of Legendre functions; Fourier analysis in geophysics. This course has a laboratory component to familiarize the student with practical applications of the tools discussed.

Lectures: Three hours per week.

Laboratories: Three hours per week.

Prerequisites: Mathematics 2000, Physics 2055 and 2820.

3210 Economic Mineral Deposits (W) is an introduction to the study of mineral deposits and definition of the basic physio-chemical parameters of ore deposit formation. The course involves a systematic review of genetic models for the principal types of metallic mineral deposits, and links these models to a common theme of the relationship between lithosphere-hydrosphere-biosphere interactions and metallogeny. Laboratory exercises involve examination of representative suites of samples from different types of metallic mineral deposits and provide an introduction to the use of reflected light microscopy.

Prerequisites: EITHER Earth Sciences 2031, 2502 and 2905; OR Earth Sciences 2031 and Chemistry 3211; OR Engineering 3610 and Engineering 3205.

3600 Environmental Geology (F) examines the application of basic concepts and fundamental principles of geochemistry in evaluating natural and human-induced change through time on the interaction of the Earth's lithosphere, hydrosphere, atmosphere and biosphere; includes the effects of contaminants on global change. Laboratory time will be used for short field-based studies and for exercises examining the effects of contaminants on global change.

Prerequisites: EITHER Earth Sciences 2502; OR Earth Sciences 1000, Chemistry 2210 and Chemistry 2300.

3611 Engineering Geology (W) examines basic concepts in soil, rock and fracture mechanics; classification of soil, rock and rock masses; special topics include the engineering and environmental aspects and issues of: slope development and underground excavations in soils and rocks; the development of hydroelectric and irrigation projects; the nuclear fuel cycle; resource developments in sensitive terrains. This course includes a laboratory component.

Prerequisites: Mathematics 1001 or permission of instructor.

Note: *Credit may not be obtained for Earth Sciences 3611 and the former Earth Sciences 4611.*

3702 Lithification, Diagenesis and Sedimentary Rock Properties

provides a conceptual and practical overview of the transformation of sediments into sedimentary rocks through compaction, cementation and mineral reactions, and the resultant modifications of rock composition, rock fabrics, and associated porous media characteristics (e.g. porosity). Both descriptive and analytical methods are integrated in laboratories that include carbonate and sandstone petrology (hand samples and thin sections), geological analysis of selected wireline logs, and the analysis of fluid reservoir properties.

Prerequisites: Earth Sciences 2031, 2702 and 2905.

3811 Paleontology (W) outlines the major changes in life forms from Archean times through the Phanerozoic to the present day, including details of invertebrate and vertebrate faunas and major floral groups; mechanisms and effects of mega- and micro-evolution in the fossil record; biology and classification of organisms and summaries of their geological significance in biostratigraphy, paleoecology and rock-building; relationships between major cycles of evolution and extinction to global processes. This course has a laboratory component.

Prerequisites: EITHER Biology 2120 (or Biology 1001 and 1002) and Earth Sciences 1002; OR Biology 2122 and 2210.

Note: *Credit may not be obtained for Earth Sciences 3811 and Biology 3811, or either the former Earth Sciences 3801 or Biology 3800.*

3905 Field Methods in Structural Geology and Stratigraphy (W) is a one credit hour course based on approximately 5 days of geological mapping in Precambrian rocks near St. John's. Emphasis is placed on application of techniques of structural analysis. Evenings will be dedicated to data analysis and preparation of structural maps and sections.

Prerequisites: Earth Sciences 2401 and 2905.

Notes: 1. *This course will be given during a special session immediately following the Winter semester examination period. Students are advised to complete this course immediately following Earth Sciences 2401. Entry is by application to the Head of the Department (or delegate) only.*

2. *Attendance for all of the field school days is required. Failure to attend may result in a failing grade or withdrawal from the course.*

5.5.8.4 Fourth Year

Note: *Not all Fourth Year courses may be offered every year.*

4053 Petrogenesis of Igneous Rocks investigates the origin of topical and important groups of igneous rocks based on experimental petrology, phase equilibria and application of geochemical tools. It further investigates the classification of igneous rocks, including the study of volcanoclastic rocks and aspects of physical volcanology. The laboratory component of the course emphasizes practical aspects of igneous petrology including geochemical characterization and use of hand-sample and field criteria.

Prerequisite: Earth Sciences 3054.

4054 Metamorphic Petrology examines relationships between metamorphism and tectonics, representation and interpretation of metamorphic mineral assemblages using compositional phase diagrams and petrogenetic grids; equilibrium thermodynamics and thermobarometry; determination of P-T-t paths. Laboratories include use of the electron microprobe to collect data for use in calculations of the conditions of formation of metamorphic assemblages, and various types of software applicable to metamorphic petrology.

Prerequisites: Earth Sciences 2401 and 3055.

4105 High Resolution Geophysics is a senior level field based course in high resolution geophysics with an emphasis on environmental applications. Topics to be covered include Ground Probing Radar, methods in refraction seismic, high resolution magnetic surveys, microgravimetry surveys, electrical and electro-magnetic methods. This course has a laboratory component in which students conduct a series of surveys over a specific site and process and interpret the collected data.

Prerequisites: Earth Sciences 3170, 3172 and 3179.

4171 Exploration Geophysics III examines techniques involved in the acquisition, processing and interpretation of multichannel seismic reflection data. Introduction to elastic properties of rocks. Introduction to advanced processing and interpretation techniques as applied to qualitative and quantitative evaluation of hydrocarbon reservoir characteristics. This course has a laboratory component designed to provide hands-on experience with data processing and interpretation.

Prerequisites: Earth Sciences 3170 and 4179.

4173 Exploration Geophysics IV examines advanced techniques in electrical and electromagnetic exploration methods including advanced IP, airborne EM surveys, EM and IP modelling, and inversion techniques; advanced methods in gravity and magnetic field exploration techniques including 2 ½-D and 3-D modelling and inversion, map processing techniques, and excess mass determination. This course has a laboratory component.

Prerequisites: Earth Sciences 3170 or 3172; and Earth Sciences 4179.

4179 Digital Signal Processing is an introduction to the theory and basic computational techniques of digital signal processing in geophysics. Topics covered include: sampling, Fourier transformation, design and application of digital filters, deconvolution, spectral analysis, two dimensional signal processing, with emphasis on geophysical applications.

Prerequisite: Earth Sciences 3179.

4211 Economic Geology provides a detailed look at the methodologies and

techniques used in the study of mineral deposits and their applications in case histories. Laboratory exercises involve solving problem sets using the various types of data from selected case studies.

Prerequisites: Earth Sciences 3054 or 3055; and Earth Sciences 3210.

4302 Advanced Marine Geology examines the geology and geophysics of ocean basins; discussion of methods of oceanic exploration, the history and development of ocean basins, interrelationships between ocean water, marine organisms, sedimentary and igneous processes.

Prerequisites: Earth Sciences 1001 or 1002 and completion of any 15 credit hours in core courses at the 3000 and/or 4000 levels (see General Note 5) in Biology, Biochemistry, Chemistry, Earth Sciences, Physics, or Geography.

4310 Earth Science Concepts, Materials and Techniques for Archaeologists - inactive course.

4400 Advanced Techniques in Structural Geology examines modern techniques of structural analysis applied to fold and fault systems including progressive deformation and strain analysis, fold mechanisms, fold morphology and classification, fold sections and profiles, superposed folding, fault geometry and morphology, brittle and ductile shear zones, and construction of balanced cross-sections. This course includes a laboratory component.

Prerequisites: Earth Sciences 2401 and 3905 and a minimum of 6 credit hours in Earth Sciences at the 3000 level.

4502 Advanced Geochemistry focuses primarily on the application of trace, radiogenic and stable isotope geochemistry to constrain the origin, mass balance and chemical fluxes within the Earth's lithosphere and asthenosphere. The course permits students to complete assignments in aspects of geochemistry that reflect their career interests.

Prerequisites: Earth Sciences 2031 and 2502 and a minimum of 6 credit hours in Earth Sciences at the 3000 level.

4503 Mineral Exploration Geochemistry is an examination of the application of geochemistry to mineral exploration, covering: the lithochemical characteristics of ore deposits, their host rocks, and element dispersion from them; the principles of sampling and analysis in exploration geochemistry; approaches to the statistical analysis, graphical presentation, and interpretation of survey results; and the design of effective geochemical surveys. Particular emphasis will be placed on case studies relevant to exploration in Newfoundland and Labrador. Laboratory/seminar sessions involve working with exemplary data sets, using computer-based software for statistical analysis and software for searching large databases and viewing the spatial relationships of different types of map data relevant to the mineral exploration industry.

Prerequisite: Earth Sciences 3210.

4601 Petroleum Origin and Occurrence is the study of the controls on the origin, migration, accumulation and production of petroleum resources, geological and geophysical methods of exploration, and the characterization of reservoir properties. Introduction to basic concepts of the geological interpretation of well logs. This course includes a laboratory component.

Prerequisites: Earth Sciences 2702; and Earth Sciences 3170 or 3172.

4602 Sedimentary Basins and Hydrocarbon Exploration provides a review of sedimentary basin types and associated petroleum systems including concepts applicable to petroleum generation, migration and accumulation. Regional-scale stratigraphic and structural concepts/models are presented as a framework for hydrocarbon fluid flow and entrapment. Laboratories include description and analysis of data typical of basin- and regional-scale exploration and appraisal of hydrocarbon resources using a variety of integrated, interdisciplinary techniques (geological, geophysical and geochemical).

Prerequisites: Earth Sciences 2401, 2702 and 3170.

Note: *Credit may not be obtained for Earth Sciences 4601 and Earth Sciences 4602.*

4603 Reservoir Characterization provides a review of the sedimentary, stratigraphic and structural setting of hydrocarbon reservoirs and the geological controls on reservoir quality. Reservoir types and methods of study are presented to evaluate their key properties for the development and production of hydrocarbons. Laboratories include detailed subsurface correlation and mapping, log analysis, interpretation of reservoir data (e.g. capillary pressure, porosity, permeability and production data).

Prerequisites: Earth Sciences 2401, 2702, 3170 and 3702.

Note: *Credit may not be obtained for Earth Sciences 4601 and Earth Sciences 4603.*

4610 Hydrogeology examines geology and its relationship to groundwater occurrence and exploitation: basic theory, groundwater flow systems, surface-groundwater interactions and changes in water quality, field and laboratory techniques, hydrogeological aspects of waste disposal and resource development. This course includes a laboratory component.

Prerequisites: Earth Sciences 2502 or permission of instructor.

4700 Facies Models and Sequence Stratigraphy provides a detailed examination of recent siliciclastic sedimentary environments, their associated facies models, and application of this knowledge to

understanding the origin and character of sandstone hydrocarbon reservoirs. Laboratories consist of several full-day field exercises in Proterozoic and Paleozoic rocks of the Avalon Peninsula, and core studies of reservoir facies in the Mesozoic Jeanne d'Arc Basin of the Grand Banks.

Prerequisite: Earth Sciences 2702 and a minimum of 6 credit hours in Earth Sciences at the 3000 level.

Note: *Because of the several full-day field trips (usually on Thursday) and to avoid timetable conflicts, students are strongly advised not to take courses outside the department that have contact hours on the same day at the laboratories in this course.*

4800 Advanced Paleontology (same as Biology 4800) is a field, lecture, laboratory and seminar course dealing with selected topics in general and applied paleontology. Topics include measuring evolution and extinction, population paleontology, functional morphology, paleoecology, statistical methods for paleontological studies, and applications in petroleum, mining, and environmental studies.

Prerequisites: Earth Sciences 3811, and Statistics 2510 or Mathematics 2000.

4901 Tectonic Regimes (F) is a lecture and seminar course describing the tectonic regimes of the lithosphere, with emphasis on the interactions of structure, sedimentology, igneous- metamorphic petrology and paleogeography; topics covered include stress and deformation of the lithosphere, and the evolution of passive, conservative and active margins; regional examples will stress North American geology.

Prerequisites: Earth Sciences 2401 and 2702; and Earth Sciences 3054 or 3055.

Note: *Credit may not be obtained for Earth Sciences 4901 and the former Earth Sciences 4320.*

4902 Early Evolution of the Earth (F) - inactive course.

4903 Global Change (W) is a lecture and seminar course that studies the interaction of the atmosphere, biosphere and lithosphere; topics covered include the evolution of the biosphere, fluid circulation, global geochemical budget, global environmental changes, and chemical evolution of the hydrosphere.

Prerequisites: Earth Sciences 1001 or 1002, Biology 2120 or Biology 1001 and 1002 and completion of any 15 credit hours in core courses at the 3000 and/or 4000 levels (see General Note 5) in Biology, Biochemistry, Chemistry, Earth Sciences, or Physics; or permission of the instructor.

4905 Field Course in Geological Mapping and Regional Tectonics (F) is a two-week field school designed to allow application of techniques introduced in the third year, and to provide an introduction to the Appalachian geology of western and central Newfoundland. Reports must be submitted for grading during the fall semester. The course may be taken by others with the permission of the Head of the Department.

Prerequisites: Earth Sciences 2401, 2702, 3055 and 3905.

4910-4920 Special Topics in Earth Sciences are lecture and seminar courses given for undergraduates in their fourth or fifth year who wish to gain more specialized knowledge in a particular field of Earth Sciences than is possible through the standard course offerings. The Department will consider suggestions by students for Special Topics courses, but it must be borne in mind that such a course should normally be approved at least three months before the start of the semester in which it is to be taken.

Prerequisites: Permission of the Head of Department.

4950 Technical Report on Geoscience Employment requires the preparation of a publication-quality technical report, about 50 pages in length, based on a study undertaken during geoscience employment. The topic and scope of the study must be approved by the Head of Department prior to its commencement. The same study cannot be used as the basis of a dissertation completed for course ES499A/B. Students will present a seminar or seminars on results of the project, and will be closely advised on proper organization and writing of scientific reports. Some directed reading will be required. This course can only be used as an "additional course" under point 3. of the regulations for General degrees, and under point 4. of the regulations for Honours degrees.

Prerequisites: Completion of 9 credit hours in Earth Sciences at 3000 level, and permission of the Head of Department.

499A and 499B Dissertation is a 6 credit hour linked course based on independent study of an approved problem in the Earth Sciences. The subject of study will be decided in consultation with Faculty Advisors and must be approved in advance by the Head of Department. The dissertation cannot be based on the same study used to obtain credit for Earth Sciences 4950. The dissertation is obligatory for Honours students, but may be taken as Science credits by General students with permission of the Head. The first semester will normally involve directed reading, supervised field and/or laboratory work, and preparation of a dissertation outline and draft of a first chapter of the thesis. The second semester will be devoted to data synthesis and interpretation, to a seminar presenting the thesis results, and to preparation of a formal written report accompanied by appropriate illustrations, to be submitted for grading one week before the end of classes.

5.6 Economics

For Departmental Regulations and Course Descriptions, see Faculty of Arts section of the Calendar.

5.7 Geography

For Departmental Regulations and Course Descriptions, see Faculty of Arts section in the Calendar.

5.7.1 Programs in Geography

The following undergraduate programs are available in the Department:

1. Major in Geography (B.A., B.Sc)
2. Honours in Geography (B.A., B.Sc)
3. Minor in Geography (B.A., B.Sc)
4. Joint Programs
5. Focus in Geography
6. Diploma in Geographic Information Sciences

5.8 Mathematics and Statistics

5.8.1 Programs in Mathematics and Statistics

From the point of view of degree regulations, Applied Mathematics, Pure Mathematics, and Statistics are considered to be one subject area.

The following undergraduate programs are available in the Department:

1. Major in Applied Mathematics (B.Sc. only)
2. Major in Pure Mathematics
3. Major in Statistics
4. Honours in Applied Mathematics (B.Sc. only)
5. Honours in Pure Mathematics
6. Honours in Statistics
7. Minor in Mathematics
8. Minor in Statistics
9. Pure Mathematics/Statistics Joint Honours
10. Applied Mathematics/Computer Science Joint Major (B.Sc. only)
11. Applied Mathematics/Economics Joint Major (B.Sc. only)
12. Applied Mathematics/Physics Joint Major (B.Sc. only)
13. Pure Mathematics/Computer Science Joint Major (B.Sc. only)
14. Pure Mathematics/Economics Joint Major (B.Sc. only)
15. Statistics/Computer Science Joint Major (B.Sc. only)
16. Statistics/Economics Joint Major (B.Sc. only)
17. Joint Major in Statistics and Economics (Co-operative) (B.Sc. only)
18. Applied Mathematics/Chemistry Joint Honours (B.Sc. only)
19. Applied Mathematics/Physics Joint Honours (B.Sc. only)
20. Pure Mathematics/Computer Science Joint Honours (B.Sc. only)
21. Statistics/Computer Science Joint Honours (B.Sc. only)
22. Statistics/Biology Joint Honours (B.Sc. only)

Details of these programs are given after the **Regulations for the Honours Degree of Bachelor of Science**.

5.8.2 Regulations

1. At most 9 credit hours in Mathematics will be given for courses completed from the following list subject to normal credit restrictions: Mathematics 1000, 1031, 1050, 1051, the former 1080, the former 1081, 1090, the former 1150 and 1151.
2. At most 6 credit hours in courses below the 2000 level can be used toward the course requirements in Mathematics and Statistics for the Major, Joint Major, Honours or Joint Honours in Applied Mathematics, Pure Mathematics or Statistics.
3. In the program descriptions that follow, Mathematics 1000 may be replaced by the former Mathematics 1081.
4. Credit may be obtained for only one of Statistics 2500, 2510, 2550 and Psychology 2900. Credit may be obtained for only one of Statistics 2501, 2560 (former 2511), and Psychology 2901.
5. Students with credits in Mathematics or Statistics not listed in this Calendar must consult the department for equivalency before taking any course listed below.
6. The former Mathematics 1150 and Mathematics 1151 were courses designed specifically for students who intended to graduate with a degree in Primary or Elementary Education. No other students can receive credit for these courses. These courses are not acceptable as alternatives to any other First Year Mathematics course listed in this calendar. Students who have received credit for Education 125 or Mathematics 115/125 cannot receive additional credit for the former Mathematics 1150 or Mathematics 1151 or the current Mathematics 1050 or Mathematics 1051.
7.
 - a. For the current academic year the Mathematics Placement Test (MPT) will be used to determine placement in the following courses: Mathematics 1000, Mathematics 1050, Mathematics 1051 and Mathematics 1090.
 - b. For subsequent years, students intending to register for the first time in any course below the 2000 level, must first submit a score for one of the following:
 - i. Advanced Placement Calculus Examination;
 - ii. Other standardized tests acceptable to the Department of Mathematics and Statistics.

5.8.3 Faculty Advisors

Normally, the Undergraduate Officer will be the advisor for each student who has undertaken a major in Applied or Pure Mathematics, and the Deputy Head (Statistics) will be the advisor for any student involved in a major in Statistics. Students should consult with their advisor at least once each semester to ensure that their choice of courses is appropriate.

Note: *The Department of Mathematics and Statistics will endeavour to give appropriate advice to students registered in its programs. However, the department points out that it is the responsibility of the student to see that his or her academic program meets the University's regulations in all respects. Students are referred to the **UNIVERSITY REGULATIONS - General Academic Regulations (Undergraduate), Registration, Student Responsibility**. The department accepts no responsibility for any matter arising from an inappropriate and/or improperly recorded registration.*

5.8.4 Course Numbering System

All undergraduate courses offered by the Department of Mathematics and Statistics are identified to year by the first digit and to subject area by the second digit as follows:

First Digit

- 1- First Year
- 2- Second Year
- 3- Third Year
- 4- Fourth and Fifth Year

Second Digit

- 1- Applied Mathematics
- 2- Applied Mathematics and Pure Mathematics
- 3- Pure Mathematics
- 4- Pure Mathematics and Statistics
- 5- Statistics

5.8.5 Major in Applied Mathematics (B.Sc. Only)

Students shall complete the following requirements:

1. Mathematics 1000, 1001, 2000, 2050, 2051, 3000, 3001, Applied Mathematics 3100, 3132, 3161, Applied Mathematics/Pure Mathematics 3202, 3260, Applied Mathematics 4160, 4190.
2. Three credit hours in Applied Mathematics courses numbered 3000 or higher.
3. A computing course, early in your program. Computer Science 1510 is highly recommended.
4. A designated technical writing course offered by a Science department. Applied Mathematics 2130 is recommended. The technical writing course is prerequisite to some 3000-level courses.
5. Physics 1050 (or 1020) and 1051.
6. A statistics course. Statistics 3410 is recommended.

5.8.6 Major in Pure Mathematics

Students shall complete the following requirements:

1. Mathematics 1000, 1001, 2000, 2050, 2051, Pure Mathematics 2320, Mathematics 3000, Mathematics 3001, Pure Mathematics 3320;
2. One of Applied Mathematics/Pure Mathematics 3202, 3210, 3260;
3. One of Pure Mathematics 3330, 3370;
4. Twelve further credit hours in Pure Mathematics courses numbered 3000 or higher, at least 6 credit hours of which must be in courses numbered 4000 or higher;
5. A computing course. Computer Science 1510 is recommended.
6. A designated technical writing course offered by a Science department. Applied Mathematics 2130 is recommended.
7. A statistics course. Statistics 3410 is recommended.

5.8.7 Major in Statistics

Students shall complete the following requirements:

1. Mathematics 1000, 1001, 2000, 2050, 2051, 3000, Pure Mathematics/Statistics 3410, 3411, Statistics 3520, 3521, 3530, 4590;
2. Nine further credit hours in Statistics courses numbered 3000 or higher at least 3 credit hours of which must be in a course numbered 4000 or higher excluding Statistics 4581;
3. Computer Science 2602.
4. Mathematics 3001 is recommended.

5.8.8 Honours in Applied Mathematics (B.Sc. Only)

See General Regulations for Honours Degree. Students shall complete the following:

1. Mathematics 1000, 1001, 2000, 2050, 2051, 3000, 3001, Applied Mathematics 2130, 3100, 3111, 3132, 3161, Applied Mathematics/Pure Mathematics 3202, 3210, 3260, Pure Mathematics/Statistics 3410, Applied Mathematics 4160, 4162, 4170, 4180, 4190, 4199;
2. A computing course early in the program is required. Computer Science 1510 is recommended.
3. Physics 1050 (or 1020) and 1051, Physics 3220, and Physics 3230.
4. nine further credit hours in courses to be chosen from the following: Applied Mathematics/Pure Mathematics 3240, Pure Mathematics/Statistics 3411, Applied Mathematics 4100, Applied Mathematics 4102, Applied Mathematics 4131, Applied Mathematics 4132, Applied Mathematics 4133, Applied Mathematics 4140, Applied Mathematics 4161, Applied Mathematics/Pure Mathematics 4230, Applied Mathematics/Pure Mathematics 4240, Applied Mathematics/Pure Mathematics 4280-4290.

5.8.9 Honours in Pure Mathematics

See General Regulations for Honours Degree. Students shall complete the following requirements:

1. Mathematics 1000, 1001, 2000, 2050, 2051, 3000, 3001, Applied Mathematics 2130, Pure Mathematics 2320, Statistics 2510, Applied Mathematics/Pure Mathematics 3202, 3210, 3260, Pure Mathematics 3300, 3301, 3320, 3330, 4300, 4310, 4399;
2. Either Pure Mathematics 3340 or 3370;

3. Either Pure Mathematics 4320 or 4321;
4. Twelve further credit hours in Pure Mathematics courses numbered 3000 or higher, at least 9 credit hours of which must be in courses numbered 4000 or higher;
5. A computing course early in the program is required. Computer Science 1510 is recommended.

5.8.10 Honours in Statistics

See General Regulations for Honours Degree. Students shall complete the following requirements:

1. Mathematics 1000, 1001, 2000, 2050, 2051, 3000, 3001, Applied Mathematics/Pure Mathematics 3202, 3210, Pure Mathematics/Statistics 3410, 3411, Statistics 3520, 3521, 3530, Pure Mathematics/Statistics 4410, Statistics 4590, 4599;
2. Eighteen further credit hours in Statistics courses including at least 12 credit hours in courses numbered 4000 or higher excluding Statistics 4581;
3. Computer Science 2602, Computer Science 3731.
4. Pure Mathematics/Statistics 4400 and Pure Mathematics/Statistics 4401 are recommended.

5.8.11 Minor in Mathematics

A total of 24 credit hours in courses offered by the Department of Mathematics and Statistics is required of which only 6 credit hours shall be in courses at the 1000 level and at least 6 credit hours shall be in courses numbered 3000 or higher.

5.8.12 Minor in Statistics

The courses required for a minor in Statistics are:

1. Mathematics 1000, 1001; Statistics 2500 or 2510, Statistics 2501 or 2560.
2. Twelve further credit hours in Statistics courses numbered 3000 or higher excluding Statistics 4581.

It is recommended that Mathematics 2000 and Mathematics 2050 be taken since they are prerequisite to several further Statistics courses.

5.8.13 Course List

In accordance with Senate's *Policy Regarding Inactive Courses*, the course descriptions for courses which have not been offered in the previous three academic years and which are not scheduled to be offered in the current academic year have been removed from the following listing. For information about any of these inactive courses, please contact the Head of the Department.

In the descriptions of the courses which follow, the symbol (F) represents the Fall and (W) represents Winter. These labels are intended to indicate the semester when the course is generally offered. Unlabelled courses are offered as demand or programs dictate and as resources permit. The department tries to offer a variety of 1000-, 2000- and 3000-level courses during the spring semester (or intersession or summer session) every year. Students are encouraged to consult the department regularly for specific planned offerings, semester by semester.

5.8.13.1 Foundation Courses

102F, 103F and 104F Mathematics Skills Program are non-credit courses intended for those students who either have a weak background in mathematics or are returning to the subject after some years. The program enables students to master mathematical operations such as those involving whole numbers, fractions, decimals, percents, integers, exponents, linear equations, algebraic and rational expressions, formulas, graphs, systems of linear equations, basic trigonometry, exponents and radicals, and quadratics.

5.8.13.2 Accelerated M103F/M1051 Mathematics Skills Program/Finite Mathematics II (W)

103F A non-credit course enabling students to master mathematics operations such as those involving algebraic and rational expressions, formulas, graphs, systems of linear equations, basic trigonometry and number systems. / **1051** is a credit course with topics including elementary matrices, linear programming, elementary number theory, mathematical systems and geometry. Meets for three 50 minute classes and two 75 minute classes per week.

Prerequisites/Co-requisites: Mathematics 102F and a recommendation by an MLC instructor resulting in approval by the MLC Director.

5.8.13.3 Common Core Mathematics Courses

1000 Calculus I (F) & (W) is an introduction to differential Calculus including logarithmic, exponential and trigonometric functions. Four hours per week.

Prerequisite: Mathematics 1090 or a combination of placement test and high school Mathematics scores acceptable to the department.

Note: *Effective Winter 2000, the credit restriction between Mathematics 1000 and the former 1080 has been lifted. However, credit cannot be obtained for both Mathematics 1000 and the former 1081.*

1001 Calculus II (F) & (W) is an introduction to integral Calculus with applications. In addition to three lectures per week there will be a one and one-half hour problem lab.

Prerequisite: Mathematics 1000 or 1081.

Note: *Credit cannot be obtained for both Mathematics 1001 and either the former Engineering 1411 or the former Engineering 2413.*

1031 Mathematical Problem Solving - inactive course.

1050 Finite Mathematics I (F) & (W) covers topics which include sets, logic, permutations, combinations and elementary probability.

Four hours per week.

Prerequisite: A combination of placement test and high school mathematics scores acceptable to the department or Mathematics 103F.

Notes: 1. *With the exception of those already admitted at the time of registration in this course to a B.Ed. program that requires this course, students who already have obtained credit for six or more Mathematics credit hours numbered 2000 or above are not permitted to register for this course nor can they receive credit for it.*

2. *Credit cannot be obtained for Mathematics 1050 and the former 1150.*

1051 Finite Mathematics II (F) & (W) covers topics which include elementary matrices, linear programming, elementary number theory, mathematical systems, and geometry.

Four hours per week.

Prerequisite: A combination of placement test and high school mathematics scores acceptable to the department or Mathematics 103F.

Notes: 1. *With the exception of those already admitted at the time of registration in this course to a B.Ed. program that requires this course, students who already have obtained credit for six or more Mathematics credit hours numbered 2000 or above are not permitted to register for this course nor can they receive credit for it.*

2. *Credit cannot be obtained for Mathematics 1051 and the former 1151.*

1090 Algebra and Trigonometry (F) & (W) provides students with the essential prerequisite elements for the study of an introductory course in calculus. Topics include algebra, functions and their graphs, exponential and logarithmic functions, trigonometry, polynomials, and rational functions.

Four hours per week.

Prerequisite: A combination of placement test and high school Mathematics scores acceptable to the department or Mathematics 104F.

Note: *Students will not receive credit for Mathematics 1090 if they have previously received credit or are currently registered for Mathematics 1000, 1001, the former 1080, or the former 1081.*

2000 Calculus III (F) & (W) is a study of the differential calculus of functions of two variables, an introduction to convergence of infinite sequences and series. In addition to three lectures per week there will be a one and one-half hour problem lab.

Prerequisite: Mathematics 1001.

Note: *Credit cannot be obtained for both Mathematics 2000 and any of the former Engineering 1411, 1412, 2412, or 2413.*

2050 Linear Algebra I (F) & (W) includes the topics: Euclidean n-space, vector operations in 2- and 3-space, complex numbers, linear transformations on n-space, matrices, determinants, and systems of linear equations.

Prerequisite: Mathematics 1000 or six credit hours in first year Mathematics courses.

Note: *Credit cannot be obtained for both Mathematics 2050 and the former Engineering 2402.*

2051 Linear Algebra II (F) & (W) includes the topics: real and complex vector spaces, basis, dimension, change of basis, eigenvectors, inner products, and diagonalization of Hermitian matrices.
Prerequisite: Mathematics 2050.

2075 Introduction to the History of Mathematics - inactive course.

2090 Mathematics of Finance covers the topics: simple and compound interest and discount, forces of interest and discount, equations of value, annuities and perpetuities, amortization schedules and sinking funds, bonds and other securities, contingent payments.
Prerequisite: Mathematics 1001.

2091 Introduction to Actuarial Mathematics - inactive course.

3000 Real Analysis I (F) & (W) covers proof techniques, structure of the real numbers, sequences, limits, continuity, uniform continuity, differentiation.

Three lecture hours and one laboratory hour per week.

Prerequisite: Mathematics 2000.

Note: *Credit can be obtained for only one of Mathematics 3000 and the former Mathematics 2001.*

3001 Real Analysis II (F) & (W) examines Infinite series of constants, sequences and series of functions, uniform convergence and its consequences, power series, Taylor series, Weierstrass Approximation Theorem.

Three lecture hours and one laboratory hour per week.

Prerequisite: Mathematics 3000.

Note: *Credit cannot be received for both of Mathematics 3001 and the former Applied Mathematics/Pure Mathematics 3201.*

5.8.13.4 Applied Mathematics Courses

2130 Technical Writing in Mathematics (W) is a project oriented course combining mathematical investigation and technical writing. By using computer programming, graphical and typesetting tools, students will explore mathematical concepts and will produce technical reports of professional quality. The latter will combine elements of writing and graphics to convey technical ideas in a clear and concise manner.

Prerequisites: Mathematics 1001 and (Computer Science 1510 or 1710 or 2710 or 2602 or permission of the Head of Department).

Notes: 1. *First priority for enrolment in this course is given to students who are Applied or Pure Mathematics majors. Other students wishing to register should direct inquiries to the head of department.*

2. *This course qualifies as a Research/Writing course in the Faculty of Arts.*

3100 Introduction to Dynamical Systems (W) examines flows, stability, phase plane analysis, limit cycles, bifurcations, chaos, attractors, maps, fractals. Applications throughout.

Three lecture hours per week.

Prerequisite: Applied Mathematics/Pure Mathematics 3260.

Note: *Credit can be obtained for only one of Applied Mathematics 3100 and the former 3190.*

3111 Applied Complex Analysis examines mapping by elementary functions, conformal mapping, applications of conformal mapping, Schwarz-Christoffel transformation, Poisson integral formula, poles and zeros, Laplace transforms and stability of systems, analytic continuation.

Prerequisite: Applied Mathematics/Pure Mathematics 3210.

3132 Numerical Analysis I (W) is an introduction to numerical analysis, round-off error, iterative methods for nonlinear equations in one variable, interpolation and polynomial approximation, discrete least-squares approximation, numerical differentiation and integration.

Prerequisites: Mathematics 3000 or Applied Mathematics/Pure Mathematics 3260, and a computing course (Computer Science 1510 is recommended).

Note: *Credit cannot be obtained for both Applied Mathematics 3132 and Computer Science 3731.*

3161 Ordinary Differential Equations II (F) examines power series solutions, method of Frobenius, Bessel functions, Legendre polynomials and others from classical Physics, systems of linear first order equations, fundamental matrix solution, numerical methods for initial value problems, existence and uniqueness of solutions.

Prerequisites: Applied Mathematics/Pure Mathematics 3202 and Applied Mathematics/Pure Mathematics 3260.

3202 Vector Calculus (F) & (W) deals with functions of several variables, Lagrange multipliers, vector valued functions, directional derivatives, gradient, divergence, curl, transformations, Jacobians, inverse and implicit function theorems, multiple integration including change of variables using polar, cylindrical and spherical co-ordinates, Green's theorem, Stokes' theorem, divergence theorem, line integrals, arc length.

Prerequisite: Mathematics 2000 and 2050.

Note: *Credit cannot be obtained for both Applied Mathematics/Pure Mathematics 3202 and Physics 3810.*

3210 Introduction to Complex Analysis (F) examines complex numbers, analytic functions of a complex variable, differentiation of complex functions and the Cauchy-Riemann equations, complex integration, Cauchy's theorem, Taylor and Laurent series, residue theory and applications.

Prerequisite: Mathematics 3000.

3240 Applied Graph Theory (F) examines algorithms and complexity, definitions and basic properties of graphs, Eulerian and Hamiltonian chains, shortest path problems, graph coloring, planarity, trees, network flows, with emphasis on applications including scheduling problems, tournaments, and facilities design.

Prerequisite: Pure Mathematics 2320.

Note: *Credit cannot be obtained for both Applied Mathematics/Pure Mathematics 3240 and Computer Science 2741.*

3260 Ordinary Differential Equations I (F) & (W) examines direction fields, equations of first order and first degree, higher order linear equations, variation of parameters, methods of undetermined coefficients, Laplace transforms, systems of differential equations. Applications include vibratory motion, satellite and rocket motion, pursuit problems, population models and chemical kinetics.

Prerequisite: Mathematics 2000.

Note: *Credit cannot be obtained for both Applied Mathematics/Pure Mathematics 3260 and Engineering 3411.*

4100 Applied Functional Analysis - inactive course.

4102 Stochastic Methods in Applied Mathematics - inactive course.

4130 Introduction to General Relativity (same as Physics 4220) studies both the mathematical structure and physical content of Einstein's theory of gravity. Topics include the geometric formulation of special relativity, curved spacetimes, metrics, geodesics, causal structure, gravity as spacetime curvature, the weak-field limit, geometry outside a spherical star, Schwarzschild and Kerr black holes, Robertson-Walker cosmologies, gravitational waves, an instruction to tensor calculus, Einstein's equations, and the stress-energy tensor.

Prerequisites: Applied Mathematics/Pure Mathematics 3202 and one of Physics 3220, Applied Mathematics/Pure Mathematics 4230 or permission of the Head of Department. Applied Mathematics/Pure Mathematics 4230 may be taken concurrently.

4131 Numerical Linear Algebra - inactive course.

4132 Introduction to Optimization - inactive course.

4133 Numerical Optimization - inactive course.

4140 Introduction to Mathematical Control Theory - inactive course.

4160 Partial Differential Equations I (F) covers two point boundary value problems, Fourier series, Sturm-Liouville theory, canonical forms, classification and solution of linear second order partial differential equations in two independent variables, separation of variable, integral transform methods.

Prerequisites: Applied Mathematics/Pure Mathematics 3202 and Applied Mathematics/Pure Mathematics 3260.

4161 Integral Equations - inactive course.

4162 Numerical Methods for Partial Differential Equations cover finite differences, finite elements, discretization schemes, stability analysis. Application to parabolic, elliptic and hyperbolic problems.

Prerequisite: Applied Mathematics 3132, 4160.

4170 Partial Differential Equations II covers first order equations, Cauchy problems, Cauchy-Kowalewska theorem, second order equations, canonical forms, wave equations in higher dimensions, method of spherical means, Duhamel's principle, potential equation, Dirichlet and Neuman problem, Green's function and fundamental solution, potential theory, heat equation, Riemann's method of integration, method of plane and Riemann waves for systems of PDEs of the first order.

Prerequisite: Applied Mathematics 4160.

4180 Introduction to Fluid Dynamics (same as Physics 4205) covers basic observations, mass conservation, vorticity, stress, hydrostatics, rate of strain, momentum conservation (Navier-Stokes equation), simple viscous and inviscid flows, Reynolds number, boundary layers, Bernoulli's and Kelvin's theorems, potential flows, water waves, thermodynamics.

Prerequisites: Physics 3220 and either Applied Mathematics 4160 or Physics 3821.

4190 Mathematical Modelling (W) is intended to develop students' skills in mathematical modelling and competence in oral and written presentations. Case studies in modelling will be analyzed. Students will develop a mathematical model and present it in both oral and report form.

Prerequisites: Applied Mathematics 3100, Applied Mathematics 3161, Applied Mathematics 4160, and a technical writing course offered by a Science department (Applied Mathematics 2130 is recommended).

4199 Applied Mathematics Honours Project requires the student, with supervision by a member of the department, to prepare a dissertation in an area of Applied Mathematics. Although original research work by the student will not normally be expected, the student must show an ability and interest to learn and organize material independently. A one hour presentation at the end of the semester will be given by the student.

Prerequisite: Registration in an Honours or Joint Honours program in Applied Mathematics.

4230 Differential Geometry covers theory of curves, Frenet relations, curvature and torsion, singular points of curves, first and second quadratic

forms, classification of points on a surface, Gaussian curvature, Gauss-Weingarten theorem, Christoffel's symbols, theorem Egregium, Gauss-Cadazzi-Mainardi theorem, internal geometry of surfaces, isometric and conformal mappings, geodesic curvature and torsion, parallel displacement, Gauss-Bonnet theorem.

Prerequisite: Applied Mathematics/Pure Mathematics 3202.

4240 Differential and Integral Calculus on Manifolds - inactive course.

4280-4290 Special Topics in Pure and Applied Mathematics

Prerequisite: Permission of Head of Department.

Note: *Consult the department for a list of titles and information regarding availability.*

5.8.13.5 Pure Mathematics Courses

2320 Discrete Mathematics (F) & (W) covers basic concepts of mathematical reasoning, sets and set operations, functions, relations including equivalence relations and partial orders as illustrated through the notions of congruence and divisibility of integers, mathematical induction, principles of counting, permutations, combinations and the Binomial Theorem.

Prerequisite: Mathematics 1001 or 2050.

Note: *Credit cannot be obtained for both Pure Mathematics 2320 and Computer Science 2740.*

3202 Vector Calculus (F) & (W) see Applied Mathematics 3202.

3210 Introduction to Complex Analysis see Applied Mathematics 3210.

3240 Applied Graph Theory see Applied Mathematics 3240.

3260 Ordinary Differential Equations I see Applied Mathematics 3260.

3300 Set Theory is an introduction to Mathematical Logic, functions, equivalence relations, equipotence of sets, finite and infinite sets, countable and uncountable sets, Cantor's Theorem, Schroeder-Bernstein Theorem, ordered sets, introduction to cardinal and ordinal numbers, logical paradoxes, the axiom of choice.

Prerequisite: Pure Mathematics 2320.

3301 Integration and Metric Spaces is a brief review of the Riemann integral, Riemann-Stieltjes integration, metric spaces, the Baire Category Theorem, uniform continuity, the Banach Contraction principle, the Weierstrass Approximation Theorem and the Stone-Weierstrass Theorem are covered.

Prerequisite: Mathematics 3001.

3303 Introductory Geometric Topology - inactive course.

3320 Abstract Algebra (F) is an introduction to groups and group homomorphisms including cyclic groups, cosets, Lagrange's theorem, normal subgroups and quotient groups, introduction to rings and ring homomorphisms including ideals, prime and maximal ideals, quotient rings, integral domains and fields.

Prerequisite: Pure Mathematics 2320.

3321 Applied Algebra - inactive course.

3330 Euclidean Geometry (F) is classical Euclidean geometry of the triangle and circle, the inversion transformation, including the theorem of Feuerbach. Elliptic and hyperbolic geometries.

Prerequisite: Pure Mathematics 2320 or Mathematics 2051.

3331 Projective Geometry includes course topics: projective space, the principle of duality, mappings in projective space, conics and quadrics.

Prerequisite: Pure Mathematics 2320 or Mathematics 2051.

3340 Introductory Combinatorics (W) includes topics: distributions, the binomial and multinomial theorems, Stirling numbers, recurrence relations, generating functions and the inclusion-exclusion principle. Emphasis will be on applications.

Prerequisite: Pure Mathematics 2320.

3370 Introductory Number Theory (F) examines perfect numbers and primes, divisibility, Euclidean algorithm, greatest common divisors, primes and the unique factorization theorem, congruences, cryptography (secret systems), Euler-Fermat theorems, power residues, primitive roots, arithmetic functions, Diophantine equations, topics above in the setting of the Gaussian integers.

Prerequisite: Pure Mathematics 2320.

3410 Mathematical Statistics I (F) covers basic probability concepts, combinatorial analysis, conditional probability, independence, random variable, distribution function, mathematical expectation, Chebyshev's inequality, distribution of two random variables, binomial and related distributions, Poisson, gamma, normal, bivariate normal, t , and F distributions, transformations of variables including the moment-generating function approach.

One and a half hour tutorial period weekly.

Prerequisite: Mathematics 2000.

3411 Mathematical Statistics II (W) examines sampling distributions. Limiting distributions, central limit theorem, minimum variance unbiased estimators, confidence intervals, MLE and its asymptotic properties, exponential family, sufficient statistics, Rao-Cramér inequality, efficiency, Neyman-Pearson lemma, chi-square tests, likelihood ratio test.

One and a half hour tutorial period weekly.

Prerequisite: Pure Mathematics/Statistics 3410.

4230 Differential Geometry see Applied Mathematics 4230.

4240 Differential and Integral Calculus on Manifolds see Applied Mathematics 4240.

4280-4290 Special Topics in Pure and Applied Mathematics

Prerequisite: Permission of Head of Department.

Note: *Consult the department for a list of titles and information regarding availability.*

4300 General Topology examines topological structure on a set, neighborhood, open and closed sets, continuity, sub-spaces and quotient spaces, connectedness, relation between topologies, base and sub-base, product spaces, applications to Euclidean spaces. Hausdorff, regular, normal and compact spaces, metric spaces, compacta and continua, metrizable.

Prerequisite: Pure Mathematics 3300 or 3301, or both Mathematics 3000 and Pure Mathematics 3303.

4301 Algebraic Topology - inactive course.

4302 Functional Analysis - inactive course.

4310 Complex Function Theory examines topology of \mathbf{C} , analytic functions, Cauchy's theorem with proof, Cauchy integral formula, singularities, argument principle, Rouché's theorem, maximum modulus principle, Schwarz's lemma, harmonic functions, Poisson integral formula, analytic continuation, entire functions, gamma function, Riemann-Zeta function, conformal mapping.

Prerequisite: Pure Mathematics 3301 and Applied Mathematics/Pure Mathematics 3210.

4320 Ring Theory examines factorization in integral domains, structure of finitely generated modules over a principal ideal domain with application to Abelian groups, nilpotent ideals and idempotents, chain conditions, the Wedderburn-Artin theorem.

Prerequisite: Pure Mathematics 3320.

4321 Group Theory examines permutation groups, Sylow theorems, normal series, solvable groups, solvability of polynomials by radicals, introduction to group representations.

Prerequisite: Pure Mathematics 3320.

4331 Galois Theory - inactive course.

4340 Combinatorial Analysis continues most of the topics started in Pure Mathematics 3340 with further work on distributions, recurrence relations and generating functions. Generating functions are used to solve recurrence relations in two variables. Also included is a study of Polya's theorem with applications.

Prerequisite: Mathematics 2000 and Pure Mathematics 3340.

4341 Combinatorial Designs includes the study of finite fields, Latin squares, finite projective planes and balanced incomplete block designs.

Prerequisite: Pure Mathematics 3320 or 3340.

4370 Number Theory - inactive course.

4375 History of Mathematics - inactive course.

4399 Pure Mathematics Dissertation requires the student, with supervision by a member of the department, to prepare a dissertation in an area of Pure Mathematics. Although original research by the student will not normally be expected, the student must show an ability and interest to learn and organize material independently. A one hour presentation at the end of the semester will be given by the student.

Prerequisite: Registration in an Honours or Joint Honours program in Pure Mathematics.

4400 Lebesgue Integration is a review of Riemann integration, outer measure, measurable sets, measurable functions, the Lebesgue integral, properties of the Lebesgue integral, sequences of integrals, Fubini's theorem.

Prerequisite: Mathematics 3001.

4401 Probability Theory examines abstract measure and integration, probability concepts, random variables, independence, Borel-Cantelli lemmas, sums of independent random variables.

Prerequisite: Mathematics 3000 and Pure Mathematics/Statistics 3410.

4402 Stochastic Processes - inactive course.

4410 Mathematical Statistics III examines multivariate normal distribution theory, applications to ANOVA and regression, other topics such as sequential tests, distribution of order statistics, nonparametrics and decision theory.

Prerequisite: Mathematics 2051 and Pure Mathematics/Statistics 3411.

5.8.13.6 Statistics Courses

Note: *All 2000 level statistics courses, Statistics 3410, 3411, 4590, and 4591 have a laboratory period weekly.*

2500 Statistics for Business and Arts Students (F) & (W) covers descriptive statistics (including histograms, stem-and-leaf plots and box

plots), elementary probability, discrete random variables, the binomial distribution, the normal distribution, sampling distribution, estimation and hypothesis testing including both one and two sample tests, paired comparisons, chi-square test, correlation and regression. Related applications.

Prerequisite: Mathematics 1000 or 6 credit hours in first year courses in Mathematics or registration in at least semester 3 of a B.N. program or permission of the head of department.

Note: *Credit can be obtained for only one of Statistics 2500, 2510, 2550, Psychology 2910, 2925 and the former 2900. Statistical computer package will be used in the laboratory, but no prior computing experience is assumed.*

2501 Further Statistics for Business and Arts Students (F) covers power calculation and sample size determination, analysis of variance, multiple regression, nonparametric statistics, index numbers, time series analysis, introduction to sampling techniques.

Prerequisite: Statistics 2500 or 2510.

Note: *Credit can be obtained for only one of Statistics 2501, 2560, the former 2511, Psychology 2911, 2950, and the former 2901. Statistical computer package will be used in the laboratory.*

2510 Statistics for Physical Science Students (F) & (W) examines elements of probability, conditional probability, Bayes' Theorem, discrete random variables, cumulative distribution function, introduction to continuous random variables, mathematical expectation, estimation of mean, proportion and variance, hypothesis testing for one-sample case.

Prerequisite: Mathematics 1000 or 1081.

Note: *Credit can be obtained for only one of Statistics 2500, 2510, 2550, Psychology 2910, 2925, the former 2900, Engineering 3423 and 4421. Normally offered twice a year, including the fall.*

2550 Statistics for Life Science Students (F) & (W) & (S) is an introduction to basic statistics methods with an emphasis on applications to life sciences and, in particular, to biology. Material includes descriptive statistics, elementary probability, binomial distribution, normal distribution, sampling distribution, estimation and hypothesis testing (both one and two sample cases), chi-square test, one way analysis of variance, correlation and simple linear regression.

Prerequisite: Mathematics 1000 or 1081.

Note: *Credit can be obtained for only one of Statistics 2500, 2510, 2550, Psychology 2910, 2925, and the former 2900. Statistical computer package will be used in the laboratory, but no prior computing experience is assumed.*

2560 Further Statistics for Science Students (W) (formerly 2511) covers estimation and hypothesis testing in the two-sample and paired sample cases, one way and two way analysis of variance, simple and multiple linear regression, chi-square tests, non-parametric tests including sign test, Wilcoxon signed rank test and Wilcoxon rank test.

Prerequisite: Statistics 2500 (with Mathematics 1000 or 1081) or Statistics 2510.

Note: *Credit can be obtained for only one of Statistics 2501, 2560, the former 2511, Psychology 2911, 2950, and the former 2901. Statistical computer packages will be used in the laboratory, but no prior computing experience is assumed.*

3410 Mathematical Statistics I see Pure Mathematics 3410

3411 Mathematical Statistics II see Pure Mathematics 3411

3520 Experimental Design I (F) is an introduction to basic concepts in experimental design, single factor designs including completely randomized, randomized blocks, Latin square and related designs, multiple comparison tests, fixed and random effects models, introduction to factorial design.

Prerequisites: Mathematics 2050 and either Pure Mathematics/Statistics 3411 or both 1001 and one of Statistics 2501 or 2560 (former 2511).

Note: *Credit can be obtained for only one of Statistics 3520, Psychology 3900 and 3950.*

3521 Regression (W) covers inferences in linear regression analysis, matrix approach to regression analysis, multiple linear regression, model selection, polynomial regression, indicator variable, problem of simultaneous inferences, multicollinearity.

Prerequisites: Mathematics 2050 and either Pure Mathematics/Statistics 3411 or both Mathematics 1001 and one of Statistics 2501 or 2560 or the former 2511.

3530 Survey Sampling I (F) covers basic concepts, randomization, sampling frames, stratified sampling, the analysis of subclasses, cluster sampling, stratified cluster sampling, unequal clusters, ratio estimates selection with probabilities proportional to size.

Prerequisites: Either Pure Mathematics/Statistics 3411 or both Mathematics 1001 and one of Statistics 2501 or 2560 or the former 2511.

3540 Time Series I covers Autocovariance, autocorrelation and correlation, stationarity, autoregressive, moving average and ARMA models, differencing, the integrated ARMA process, parameter estimation, model identification and diagnostic testing, forecasting, seasonal models, the use

of data transformation.

Prerequisites: Either Pure Mathematics/Statistics 3411 or both Mathematics 1001 and one of Statistics 2501 or 2560 or the former 2511.

3570 Reliability and Quality Control is an analysis of life, mortality and failure data, standard parametric models in reliability, quality control charts and cumulative sum charts, tolerance limits, contingency tables, interactions, application of sequential sampling.

Prerequisites: Either Pure Mathematics/Statistics 3411 or both Mathematics 1001 and one of Statistics 2501 or 2560 or the former 2511.

3590 Statistics in Applied Research - inactive course.

4400 Lebesgue Integration see Pure Mathematics 4400

4401 Probability Theory see Pure Mathematics 4401

4402 Stochastic Processes see Pure Mathematics 4402

4410 Mathematical Statistics III see Pure Mathematics 4410

4520 Experimental Design II (W) covers selected topics in ANOVA and ANCOVA including factorial experiments and unbalanced designs.

Prerequisite: Statistics 3520.

4530 Survey Sampling II (W) covers area sampling, multi-stage sampling, two-phase sampling, ratio, regression and difference estimates, composite sampling designs, sampling from imperfect frames, bias and non-sampling errors.

Prerequisites: Mathematics 2000 and Statistics 3530.

4540 Time Series II is an analysis of time series in the time domain, including stationary and non-stationary processes, autocovariance kernels and their estimators, analysis of autoregressive and moving average models, spectral analysis including the power spectrum and its estimators, periodogram, smoothed and filtered estimators.

Prerequisites: Pure Mathematics/Statistics 3411 and Statistics 3540.

4550 Non-parametric Statistics covers inferences concerning location based on one sample, paired samples or two samples, inferences concerning scale parameters, goodness-of-fit tests, association analysis, tests for randomness.

Prerequisites: one of Statistics 3520 or 3521, or Pure Mathematics/Statistics 3411.

4560 Continuous Multivariate Analysis examines the multivariate normal distribution and its marginal and conditional distributions, properties of the Wishart distribution, Hotelling's T-squared statistic, a selection of techniques chosen from among MANOVA, multivariate regression, principal components, factor analysis, discrimination and classification, clustering.

Prerequisites: Mathematics 2051, Pure Mathematics/Statistics 3410 and one of Statistics 3520, or Pure Mathematics/Statistics 3411, or Statistics 3521.

4561 Discrete Multivariate Analysis is an analysis of cross-classified categorical data, chi-square test, measures of association, multidimensional contingency tables, hypotheses of partial and conditional independence, log-linear models for Poisson, multinomial and product-multinomial sampling schemes, iterative scaling technique for maximum likelihood estimation, step-wise model selection procedures, partitioning chi-square, explanatory and response variables in contingency tables, logit models.

Prerequisite: Statistics 3520 or 3521.

4580 History of Statistics - inactive course.

4581 Quantitative Methods in Biology - inactive course.

4585 Computational Statistics is an introduction to modern computational statistics, using a statistical programming language, such as S-Plus. Emphasis is placed on use of the computer for numerical and graphical exploratory data analysis, and on crafting programs to accomplish specialized statistical procedures.

Prerequisites: Mathematics 2000, Statistics 3520, 3521. Applied Mathematics/Pure Mathematics 2130 is recommended.

4590 Statistical Analysis of Data I is for users of Statistics with emphasis placed on computer analysis of statistical problems drawn from various disciplines, descriptive statistics, analysis of univariate measurement data, chi-square tests, non-parametric tests, basic ANOVA and regression.

Prerequisite: one of Statistics 3520, or 3521, or Pure Mathematics/Statistics 3411.

4591 Statistical Analysis of Data II - inactive course.

4599 Honours Comprehensive with Directed Readings is a directed reading course with Comprehensive examination for students in Honours or Joint Honours Degree programs in Statistics only.

Prerequisite: Registration in an Honours or Joint Honours program in Statistics.

5.9 Physics and Physical Oceanography

5.9.1 Programs in Physics

The following undergraduate programs are available in the Department:

1. Major in Physics
2. Honours in Physics
3. Major in Environmental Physics
4. Honours in Environmental Physics
5. Applied Mathematics/Physics Joint Honours
6. Applied Mathematics/Physics Joint Major
7. Physics/Biochemistry Joint Honours
8. Physics/Chemistry Joint Honours
9. Physics/Computer Science Joint Honours
10. Physics/Computer Science Joint Major
11. Physics/Earth Sciences Joint Honours
12. Geophysics/Physical Oceanography Joint Honours
13. Physics/Earth Sciences Joint Major
14. Minor in Physics

Details of these joint programs are given after the **Regulations for the Honours Degree of Bachelor of Science**. Other joint programs may be arranged in consultation with the departments concerned.

- Notes:
1. The attention of students intending to follow any one of the programs listed above is drawn to the **UNIVERSITY REGULATIONS - General Academic Regulations (Undergraduate)**, governing the appropriate degree. Additional Departmental requirements are given below.
 2. Faculty advisors are available to provide advice to students who are registered in, or who are considering registering in, any of the programs. Students are urged to consult with these advisors at their earliest opportunity in order to ensure that they select appropriate courses and programs. Students with credits in Physics courses which are not listed in this calendar should consult with the Department.
 3. The six course stream consisting of Physics 1050, 1051, 2053, 2055, 2750, and 2820 or alternatively the seven course stream of Physics 1020, 1050, 1051, 2053, 2055, 2750, and 2820 is intended to provide a cohesive overview of Physics for potential Physics majors.
 4. Physics 1050 is open to and recommended for students who have completed Level II Physics, Level III Physics and Level III Advanced Mathematics. Mathematics 1000 must be taken at the same time as, or be completed prior to, taking Physics 1050. However, under certain circumstances, students enrolled in Mathematics 1090, will be allowed to register for Physics 1050 with the permission of the Department of Physics and Physical Oceanography. Students who have completed Mathematics 1090 and Physics 1050, however, are required to complete Mathematics 1000 before registering for Physics 1051.
 5. Physics 1020 is intended for students who do not qualify for Physics 1050, and while it may be taken by students who have no background in Physics it is recommended that students wishing to take Physics 1020 should have completed at least one of Level II and Level III Physics. Students who complete Physics 1020 and Mathematics 1000 are eligible for admission to Physics 1051. Students may receive credit for only one of Physics 1050 and 1020.
 6. Students who have successfully completed Advanced Placement courses in both Physics and Mathematics will normally be eligible for direct entry into Physics 1051, 2053 and 2750, all of which are offered in the Fall semester. Such students are advised to consult the Department.
 7. Where circumstances warrant, any prerequisites listed below may be waived by the Head of the Department.
 8. Supplementary examinations will be allowed in certain Physics courses which have written final examinations. Students should refer to the Faculty of Science Degree regulations for details.

5.9.2 Minor in Physics

A minor in Physics will consist of 24 credit hours in Physics courses which must include Physics 1050 (or 1020), 1051, 2053, 2055, 2750, 2820. Only 6 credit hours at the 1000 level can be used to fulfill the 24 credit hours. For those students whose major is Chemistry or Biochemistry, the 24 credit hours in Physics will not include 2053.

5.9.3 Major in Physics

1. English 1080 and English 1110 (or equivalent).
2. Chemistry 1050 and 1051 (or Chemistry 1010, 1011, and 1031).
3. Mathematics 1000 and 1001.
4. Mathematics 2000, Mathematics 2050 and Applied Mathematics/Pure Mathematics 3260.
5. Physics 1050 (or 1020) and 1051.
6. Physics 2053, 2055, 2750, 2820, 3220, 3400, 3500, 3750 and 3900.
7. An additional 12 credit hours in physics courses numbered 3000 or higher which shall include at least 6 credit hours selected from the courses numbered Physics 3000, 3150, 3300, 3410, 3550, 3600, 3751.
8. Physics 3810 or Applied Mathematics/Pure Mathematics 3202.

Mathematics 1001, 2000 and 2050 are prerequisites to many Physics courses and should be completed by the end of second year. Applied Mathematics/Pure Mathematics 3260 is co-requisite to Physics 3220 and should be completed before the winter of the third year. Those who intend to make a career in Physics should note that additional Physics courses are strongly recommended. Computer Science 2602 and Mathematics 2051 are also recommended.

5.9.4 Honours in Physics

1. English 1080 and English 1110 (or equivalent).
2. Chemistry 1050 and 1051 (or Chemistry 1010, 1011, and 1031).
3. Mathematics 1000 and 1001.
4. Mathematics 2000, 2050 and Applied Mathematics/Pure Mathematics 3260.
5. Physics 1050 (or 1020) and 1051.
6. Physics 2053, 2055, 2750, 2820, 3220, 3230, 3400, 3410, 3500, 3600, 3750, 3820, 3821, 3900, 3920, 4500, 4850, 490A/B.
7. Physics 3810 or Applied Mathematics/Pure Mathematics 3202.
8. An additional 12 credit hours in physics courses numbered 3000 or higher which shall include at least 6 credit hours selected from physics courses numbered 4000 or higher.
9. Fifteen credit hours in applicable elective courses*

Note: Certain of the graduate courses may be taken in the final year of the Honours Program with the permission of the Head of the Department.

*Only 6 credit hours at the 1000 level in each of Physics, Chemistry and Mathematics can be used to fulfil the 120 credit hours required

for the Honours program. The inclusion of Mathematics 1090, the sequence of Physics 1020, 1050 and 1051 or the substitution of Chemistry 1010, 1011 and 1031 for Chemistry 1050 and 1051 will each increase the number of credit hours required for the Honours Physics program by three.

An Honours thesis is to be presented on work undertaken by the candidate under the guidance of a Department of Physics and Physical Oceanography faculty member. The thesis comprises the 6 credit hour course Physics 490A/B. Students should seek departmental advice regarding a thesis project no later than the winter preceding the semester in which the project will be started.

The Honours Physics program in and beyond the third year requires a familiarity with computer programming and numerical analysis. In choosing electives for this program, the Department recommends that students supplement the prescribed program with the following courses Computer Science 2602 and 3731 (or Applied Mathematics 2130 and 3132). Mathematics 2051 and 3000 are also suitable electives. For specific courses and recommendations about electives, consultation with a faculty advisor in the Department is suggested.

The Department recommends that students wishing to complete the Honours Physics program in 120 credit hours follow the schedule given below. This schedule is intended for students who qualify for Physics 1050 and 1051. Other suggested course schedules are available from the Head of the Department.

Recommended Course Schedule - Honours Physics Program

Year	Semester I	Semester II
I	English 1080 Chemistry 1050 Mathematics 1000 Physics 1050 Elective	English 1110 (1101, 1102) Chemistry 1051 Mathematics 1001 Physics 1051 Elective
II	Mathematics 2000 Mathematics 2050 Physics 2053 Physics 2750 Elective	Applied Mathematics/Pure Mathematics 3202 Applied Mathematics/Pure Mathematics 3260 Physics 2055 Physics 2820 or Elective Elective
III	Physics 3220 Physics 3400 Physics 3500 Physics 3750 Physics 3820	Physics 3900 Physics 3600/4500 Physics 3230/3410 Physics Elective Elective
IV	Physics 3821 Physics 3920 Physics 4850 Physics 490A Physics Elective	Physics 4500/3600 Physics 3410/3230 Physics 490B Physics Elective Physics Elective

5.9.5 Major in Environmental Physics

1. English 1080 and English 1110 (or equivalent)
2. Chemistry 1050 and 1051 (or Chemistry 1010, 1011, and 1031)
3. Mathematics 1000 and 1001
4. Mathematics 2000, Mathematics 2050, Applied Mathematics/Pure Mathematics 3260, Applied Mathematics/Pure Mathematics 3202
5. Physics 1050 (or 1020) and 1051
6. Physics 2053, 2055, 2750, 2820, 3220, 3820, 3300, 3340, 4340
7. Physics 3400 or 3500
8. Earth Sciences 1000, 1002, 2502, 3170, 3172
9. Geography 2102, 2195, 3120
10. Biology 2120, 2600

The Major degree offers students a fair degree of latitude in choosing electives, students are encouraged to take electives from Geography and Earth Sciences: of particular merit would be any of Earth Sciences 3600, 3611 or 4105.

5.9.6 Honours in Environmental Physics

1. English 1080 and English 1110 (or equivalent)
2. Chemistry 1050 and 1051 (or Chemistry 1010, 1011, and 1031)
3. Mathematics 1000 and 1001
4. Mathematics 2000, Mathematics 2050, Applied Mathematics/Pure Mathematics 3260, Applied Mathematics/Pure Mathematics 3202
5. Physics 1050 (or 1020) and 1051
6. Physics 2053, 2055, 2750, 2820, 3220, 3820, 3821, 3300, 3340, 4205, 4300, 4340, 490A/B
7. Physics 3400 or 3500
8. Earth Sciences 1000, 1002, 2502, 3170 and 3172
9. Geography 2102, 2195, 3120
10. Biology 2120, 2600

An honours thesis is to be presented on work undertaken by the candidate under the guidance of a Department of Physics and Physical Oceanography faculty member. The thesis comprises the 6 credit hour course Physics 490A/B. Students should seek departmental advice regarding a thesis project no later than the winter preceding the semester in which the project will be started.

The Department recommends that students wishing to complete the Honours Environmental Physics program in 120 credit hours follow the schedule given below. This schedule is intended for students who qualify for Physics 1050 and 1051. Other suggested course schedules are available from the Head of the Department.

Those courses in which a grade of "B" or better or an average of 75% or higher are required, as specified in Clause 6.a. of the **Regulations for the Honours Degree of Bachelor of Science**, are 45 credit hours in Physics courses, and 15 credit hours in other courses (beyond the 1000 level) selected from the specified program courses in Earth Sciences, Geography and Biology.

Recommended Course Schedule - Honours Environmental Physics Program

Year	Semester I	Semester II
I	English 1080 Chemistry 1050 Physics 1050 Earth Sciences 1000 Mathematics 1000	English 1110 Chemistry 1051 Physics 1051 Earth Sciences 1002 Mathematics 1001
II	Physics 2053 Physics 2750 Geography 2102 Mathematics 2050 Mathematics 2000	Physics 2820 Geography 2195 Mathematics 3260 Mathematics 3202 Elective
III	Physics 3220 Physics 3820 Earth Sciences 2502 Physics 3400/3500 Physics 3340	Physics 2055 Biology 2120 Geography 3120 Earth Sciences 3170 Elective
IV	Physics 3300 Physics 3821 Biology 2600 Physics 490A Earth Sciences 3172	Physics 4300 Physics 4340 Physics 490B Physics 4205 Elective

Table of Credit Restrictions for Present Physics Courses with Former Courses

Credit May Be Obtained For Only One Course From Each of The Pairs of Courses Listed in This Table

Present Course	Former Course	Present Course	Former Course
1020	1200	3230	2210
1021	1201	1051	2050
1051	1052	1051	1061
2820	2200	3750	3700
2053	2450	3750	3850
2055	2550	490A/B	4990
2750	2700	1051	2054
3220	3200	1051	2550

Physics 1021 and the former Physics 1201 will be considered equivalent for prerequisite purposes. Physics 1051 and 2820 will be considered equivalent to the former Physics 1054 and 2054 for prerequisite purposes. Physics 1051 and the former Physics 1052 and 2050 will be considered equivalent for prerequisite purposes.

Not all courses are offered every year. Students should check with the Department prior to registration to plan programs.

5.9.7 Course List

In accordance with Senate's *Policy Regarding Inactive Courses*, the course descriptions for courses which have not been offered in the previous three academic years and which are not scheduled to be offered in the current academic year have been removed from the following listing. For information about any of these inactive courses, please contact the Head of the Department.

1020 Introductory Physics I (F) & (W) is a non-calculus based introduction to mechanics.

Prerequisite: Level III Advanced Mathematics or Mathematics 1090. Mathematics 1090 may be taken concurrently. It is recommended that students have completed at least one of level II and level III high school physics courses, however this course may be completed by someone who has no physics background provided some extra effort is made.

Lectures: Three hours per week.

Laboratories: Normally six laboratory sessions per semester, with each session lasting a maximum of three hours.

Tutorials: Optional tutorials will be available, on average one hour per week.

Note: *Credit can be obtained for only one of Physics 1020 and 1050.*

1021 Introductory Physics II (F) & (W) is a non-calculus based introduction to fluids, wave motion, light, optics, electricity and magnetism.

Prerequisites: Physics 1020 or 1050 and Mathematics 1000. Mathematics 1000 may be taken concurrently.

Lectures: Three hours per week.

Laboratories: Normally six laboratory sessions per semester, with each session lasting a maximum of three hours.

Tutorials: Optional tutorials will be available, on average one hour per week.

Note: *Credit can be obtained for only one of Physics 1021, 1051 and 1061.*

1050 General Physics I: Mechanics (F) & (W) is a calculus based introduction to mechanics. The course will emphasize problem solving.

Prerequisite: Mathematics 1000, which may be taken concurrently.

Lectures: Three hours per week.

Laboratories: Normally six laboratory sessions per semester, with each session lasting a maximum of three hours.

Tutorials: Optional tutorials will be available, on average one hour per week.

Notes: 1. *For more details regarding Physics 1050, see Note 4 under Programs in Physics.*

2. *Credit can be obtained for only one of Physics 1020 and 1050.*

1051 General Physics II: Oscillations, Waves, Electromagnetism (F) (W) & (S) is a calculus based introduction to oscillations, wave motion, physical optics and electromagnetism.

Prerequisites: Physics 1050 or 1020 (with a minimum grade of 65%) and Mathematics 1001. Mathematics 1001 may be taken concurrently.

Laboratories: Normally six laboratory sessions per semester, with each session lasting a maximum of three hours.

Tutorials: Optional tutorials will be available, on average one hour per week.

Note: *Credit can be obtained for only one of Physics 1021, 1051, and 1061.*

2053 Fluids and Thermal Physics (F) examines elasticity, fluid mechanics, thermodynamics, kinetic theory and statistical mechanics.

Prerequisites: Mathematics 1001 and Physics 1051 which may be taken concurrently.

Lectures: Three hours per week.

Laboratory: Three hours per week.

2055 Electricity and Magnetism (W) examines Gauss' Law, the

electrostatic potential, capacitance, magnetic forces and the magnetic field, electromagnetic induction, magnetic materials, ac circuits, superconductivity, the displacement current and Maxwell's equations.

Prerequisites: Mathematics 2000 and Physics 1051. Mathematics 2000 may be taken concurrently.

Lectures: Three hours per week.

Laboratory: Three hours per week.

2151 Stellar Astronomy and Astrophysics (F) & (W) covers atomic structure and spectra. The sun: radiation, energetics, magnetic field. Stars: distance, velocity, size, atmospheres, interiors. Variable stars, multiple stars, clusters and stellar associations. Stellar evolution, interstellar matter, structure of the Milky Way Galaxy. Exterior galaxies, quasi-stellar objects, pulsars. Cosmology.

Prerequisites: Six credit hours in Mathematics courses at the first year level.

Lectures: Three hours per week.

2750 Modern Physics (F) covers special relativity, quanta of light, atomic structure and spectral lines, quantum structure of atoms and molecules, nuclei and elementary particles.

Prerequisites: Mathematics 1001 and Physics 1051 which may be taken concurrently.

Lectures: Three hours per week.

Note: *Students may receive credit for only one of Physics 2750 and 2056.*

2820 Computational Mechanics (W) covers newtonian dynamics and celestial mechanics, numerical differentiation and integration, numerical solutions to mechanics problems, data and spectral analysis, Fourier series and normal modes, oscillations and vibrations, linear and non-linear oscillators, nonlinear dynamics and chaos.

Prerequisites: Physics 1051, Mathematics 2000 (Mathematics 2000 may be taken concurrently).

Lectures and Laboratories: Up to five hours per week.

3000 Physics of Device Materials (F) Structures of crystalline and amorphous solids. Excitations and transport in metals, semiconductors, and dielectrics; electronic band structures. Physics of multi-material devices including photodiodes, solid state lasers, and field-effect transistors.

Prerequisites: Physics 2055.

3150 Astrophysics I (W) is a review of macroscopic and microscopic physics. The sun: luminosity, mass, spectrum, photosphere, corona, interior. Principles of stellar structure; radiative and convective transport of energy. The virial theorem. Thermonuclear fusion; temperature dependence; the solar neutrino problem. Nucleosynthesis; the curve of binding energy; the synthesis of heavy elements. White dwarfs, neutron stars, and black holes; degenerate electron and neutron gases; Chandrasekhar's Limit. Population I and Population II stars; the Hertzsprung-Russell diagram; relationships among luminosity, mass, and effective temperature for main sequence dwarfs. Evolution of post main sequence stars.

Prerequisites: Physics 2053, 2750 (or 2056), and 2820.

Lectures: Three hours per week.

3151 Astrophysics II covers stellar spectra and classification of stars. Hertzsprung-Russell diagram; equations of stellar structure for a star in equilibrium; temperature and density dependencies of nuclear processes. Formation and classification of binary stars; mass and energy transfer in binary star systems; semidetached binaries; cataclysmic variables, pulsars, etc. Galaxies and galactic structure; active galactic nuclei; cosmological redshift. Cosmology.

Prerequisites: Physics 3150 and 3220.

Lectures: Three hours per week.

3220 Classical Mechanics I (F) covers kinematics and dynamics of a particle. Moving reference systems. Celestial mechanics. Systems of particles.

Prerequisites: Physics 2820 and Applied Mathematics/Pure Mathematics 3260. Applied Mathematics/Pure Mathematics 3260 may be taken concurrently.

Lectures: Three hours per week.

3230 Classical Mechanics II (W) covers rigid body motion. Lagrange's equations. Hamilton's equations. Vibrations. Special theory of relativity.

Prerequisites: Physics 3220 and 3810 (or Applied Mathematics/Pure Mathematics 3202) and Applied Mathematics/Pure Mathematics 3260.

Lectures: Three hours per week.

3300 Introduction to Physical Oceanography (F) deals with the physics of processes in the ocean, but provides an integrated view of the whole field of oceanography. The importance of physical processes to other aspects of oceanography is treated.

Prerequisites: Physics 2053 and Mathematics 2000.

Lectures: Three hours per week.

3340 Principles of Environmental Physics will explore the basic physical principles of light, heat, energy and sound in the natural environment. Several key aspects of physics in the environment will be covered including climate and the physical evolution of the planet and the present role of the atmosphere and ocean spectroscopy in the atmosphere and measurement and observation of the atmosphere; principles of energy generation and pollution transport in the atmosphere and ocean.

Lectures: Three hours per week.

Prerequisites: Mathematics 2000 and Physics 2053.

3400 Thermodynamics (F) covers the first and second laws of thermodynamics. Entropy. Thermodynamics of real substances. Kinetic

theory of matter. Introduction to statistical mechanics.

Prerequisites: Mathematics 2000, Physics 2053 and Physics 2750 or 2056.

Lectures: Three hours per week.

3410 Statistical Mechanics (W) covers ensembles. Classical and quantum statistical mechanics. Statistical mechanics of phase transitions. Advanced topics in statistical mechanics.

Prerequisites: Physics 3400 and 3750. Physics 3750 may be taken concurrently.

Lectures: Three hours per week.

3500 Electromagnetic Fields I (F) examines electrostatic Field: field, potential, Poisson's equation, Laplace's equation, capacitance, dielectrics, polarization, electric displacement, boundary conditions. Magnetic Field: electric current and magnetic field, vector potential, Lorentz force and relativity, changing magnetic field, inductance, magnetic materials, magnetization. Maxwell's equations.

Prerequisites: Physics 2055 and 3810 (or Applied Mathematics/Pure Mathematics 3202).

Lectures: Three hours per week.

3550 Electric Circuits (S) covers circuit elements. Simple resistive circuits. Techniques of circuit analysis. Topology in circuit analysis. Operational amplifiers. Reactive circuit elements. Natural response and step response of RL, RC and RLC circuits. Circuits driven by sinusoidal sources. Mutual inductance. Series and parallel resonance. Laplace transforms in the analysis of frequency response.

Prerequisites: Mathematics 2050, Physics 2055 and Applied Mathematics/Pure Mathematics 3260. Applied Mathematics/Pure Mathematics 3260 may be taken concurrently.

Lectures and Laboratory: Not more than six hours per week.

3551 Analogue Electronics (S) is a review of network analysis. Feedback. Electron tubes. Semiconductor diodes. Introduction to transistors. Introduction to amplifiers. Small signal models. Small signal analysis of amplifiers. Operational amplifiers. Selected topics in circuit design such as biasing, voltage regulators and power circuits, noise.

Prerequisites: Physics 3550 and Applied Mathematics/Pure Mathematics 3260.

Lectures and Laboratory: Not more than six hours per week.

This course is recommended for students with an interest in experimental Physics.

3600 Optics and Photonics I (W) covers geometrical Optics: thin lenses, mirrors, optical systems. Two-beam and multiple-beam interference phenomena. Fraunhofer Diffraction. Introduction to Maxwell's Theory: reflection, transmission, and polarization. Modulation of light waves. Fibre-optical light guides: intermodal dispersion, index profiles, loss mechanisms, single mode fibres. Optical communication systems: free space and fibre systems, emitters, detectors, amplifiers, wavelength-division multiplexing, integrated optics.

Prerequisites: Mathematics 2000 and Physics 2055.

Lectures: Three hours per week.

3750 Quantum Physics I (F) covers wave-particle duality of nature. Introduction to Quantum Mechanics. Schrödinger equation. One electron atoms. Quantum statistics.

Prerequisites: Physics 2750 (or 2056), 3220 and 3810 (or Applied Mathematics/Pure Mathematics 3202). Physics 3220 and 3810 (or Applied Mathematics/Pure Mathematics 3202) may be taken concurrently.

Lectures: Three hours per week.

3751 Quantum Physics II (W) covers multielectron atoms. Molecules. Solids - conductors and semiconductors. Superconductors. Magnetic properties. Nuclear models. Nuclear decay and nuclear reactions. Properties and interactions of elementary particles.

Prerequisite: Physics 3750.

Lectures: Three hours per week.

3810 Mathematical Analysis (F) - inactive course.

3820 Mathematical Physics II (F) examines the functions of a complex variable; residue calculus. Introduction to Cartesian tensor analysis. Matrix eigenvalues and eigenvectors. Diagonalization of tensors. Matrix formulation of quantum mechanics. Quantum mechanical spin. Vector differential operators in curvilinear coordinate systems. Partial differential equations of Mathematical Physics and boundary value problems; derivation of the classical equations, separation of variables; Helmholtz equation in spherical polar coordinates.

Prerequisites: Applied Mathematics/Pure Mathematics 3260, and Physics 3810 (or Applied Mathematics/Pure Mathematics 3202).

Lectures: Three hours per week.

3821 Mathematical Physics III (F) covers further topics on partial differential equations of Mathematical Physics and boundary value problems; Sturm-Liouville theory, Fourier series, generalized Fourier series, introduction to the theory of distributions, Dirac delta function, Green's functions, Bessel functions, ' functions, Legendre functions, spherical harmonics.

Prerequisite: Physics 3820.

Lectures: Three hours per week.

3900 Physics Laboratory I (W) is a selection of experiments based primarily on material covered in the third year courses.

Prerequisites: At least two of Physics 2053, 2820, 2055, and Physics 2750 (or 2056).

Laboratory: Six hours per week.

3920 Physics Laboratory II (F) is a selection of experiments based primarily on Modern Physics at the intermediate level.

Prerequisite: Physics 3900.

Laboratory: Six hours per week.

Note: *Prerequisite requirements for Physics courses numbered 4000 and higher may be waived by the instructor.*

4000 Solid State Physics covers crystal structure and binding, phonons and lattice vibrations, thermal properties of solids. Electrons in solids, energy bands, semi-conductors, superconductivity, dielectric properties. Magnetic properties of solids.

Prerequisites: Physics 3400 and 3750.

Lectures: Three hours per week.

4200 Classical Mechanics III is a review of Lagrange's equations. Hamilton's canonical equations. Variational principles. Nöther's theorem for particles. Special relativity of particles and the electromagnetic field. Special topics at an advanced level.

Prerequisites: Physics 3230 and 3820.

Lectures: Three hours per week.

4205 Introduction to Fluid Dynamics (same as Applied Mathematics 4180) covers basic observations, mass conservation, vorticity, stress, hydrostatics, rate of strain, momentum conservation (Navier-Stokes equation), simple viscous and inviscid flows, Reynolds number, boundary layers, Bernoulli's and Kelvin's theorems, potential flows, water waves, thermodynamics.

Prerequisites: Physics 3220 and either Applied Mathematics 4160 or Physics 3821.

Lectures: Three hours per week.

4210 Continuum Mechanics - inactive course.

4220 Introduction to general Relativity (same as Applied Mathematics 4130) studies both the mathematical structure and physical content of Einstein's theory of gravity. Topics include the geometric formulation of special relativity, curved spacetimes, metrics, geodesics, causal structure, gravity as spacetime curvature, the weak-field limit, geometry outside a spherical star, Schwarzschild and Kerr black holes, Robertson-Walker cosmologies, gravitational waves, an introduction to tensor calculus, Einstein's equations, and the stress-energy tensor.

Prerequisites: Applied Mathematics/Pure Mathematics 3202 and one of Physics 3220, Applied Mathematics/Pure Mathematics 4230 or permission of the Head of Department. Applied Mathematics/Pure Mathematics 4230 may be taken concurrently.

4300 Advanced Physical Oceanography (W) covers fundamental properties of seawater and techniques of oceanographic measurement. The dynamical equations of oceanography are derived and solutions explored by comparison with oceanic observations. Properties of waves in rotating and non-rotating fluids. Linear and non-linear wave theory are developed.

Prerequisites: Physics 3300 and 3820 or Engineering 7033 or the permission of the Instructor.

4330 Topics in Physical Oceanography - inactive course.

4340 Modelling in Environmental Physics covers the basic principles underlying environmental modelling will be developed and techniques for modelling presented and applied. Techniques for numerical modelling will be developed and simple numerical models will be developed for use in terrestrial, atmospheric and oceanic environments. Free and forced systems will be discussed and the transition to chaos and some aspects of chaotic dynamics.

Lectures: Three hours per week.

Prerequisites: Physics 3340 and Physics 3820 (or the permission of the

instructor).

4500 Electromagnetic Fields II covers multipole expansions, electrostatic fields as boundary value problems, polarizability of molecules in dielectric media, Clausius-Mossotti relation, gauges. Electromagnetic Waves: Poynting's theorem, reflection and transmission of electromagnetic waves, cavity resonators, wave guides. Electromagnetic Radiation: dipoles, antennas, quantum mechanics and electro-magnetic interactions. Selected topics in electrodynamics and applied electromagnetism.

Prerequisites: Physics 3500 and 3820.

Lectures: Three hours per week.

4600 Optics and Photonics II is a review of basic topics in wave optics. Phase sensitive imaging. Electromagnetic waves in anisotropic media. Scattering of electromagnetic waves. The physics of light sources and applications. Non-linear optics and applications.

Prerequisites: Physics 3500, 3600, and Physics 3751 (Physics 3751 may be taken concurrently).

Lectures: Three hours per week.

4700 Atomic and Molecular Physics - inactive course.

4710 Nuclear Physics - inactive course.

4820 Mathematical Physics IV - inactive course.

4850 Quantum Mechanics (F) examines postulates of quantum mechanics. Operators and operator algebra. Matrix representations. Spin and magnetic fields. Approximation methods: WKB method, time independent perturbation theory, time dependent perturbation theory, variational methods. Elementary scattering theory.

Prerequisites: Physics 3230, 3750, 3820.

Lectures: Three hours per week.

4851 Advanced Quantum Mechanics (W) covers general formulation of quantum mechanics, measurement theory and operators. Hilbert spaces. Advanced topics selected from: electron in a strong magnetic field and the Aharonov-Bohm effect; advanced scattering theory; systems of identical particles; Feynman path integral formulation of quantum mechanics; relativistic quantum mechanics; second quantization; symmetry and group theory; density matrix and mixtures.

Prerequisite: Physics 4850 and 3821.

Lectures: Three hours per week.

4900 Senior Laboratory - inactive course.

490A/B Honours Physics Thesis

6317 Underwater Acoustics covers basic theory of sound, sound in the ocean environment, wave equation, ray tracing, sonar system operation, transducers, applications.

Prerequisites: Physics 3810 (or Applied Mathematics/Pure Mathematics 3220) and 3220, or the permission of the instructor.

Lectures: Three hours per week.

6318 Ocean Climate Modelling covers numerical techniques, finite difference, finite element and spectral methods. Introduction to the climate system. Ocean climate models. Box models. Variability on interdecadal, centennial and geological scales. Zonally averaged models. 3-D ocean modelling. Thermohaline circulation. General circulation models. Climate modelling and global warming.

Prerequisites: Physics 3810 (or Applied Mathematics/Pure Mathematics 3202), Physics 3300 and the completion of any 15 credit hours in core courses at the 3000 or 4000 level in the Faculty of Science, or the permission of the instructor.

Lectures: Three hours per week.

5.10 Psychology

5.10.1 Programs in Psychology

The following undergraduate programs are available in the Department.

1. Major and Honours in Psychology (B.A. or B.Sc.)
2. Major and Honours in Behavioural Neuroscience (B.Sc. only)
3. Minor in Psychology (B.A. or B.Sc.)
4. Joint Honours in Psychology and Biology (B.Sc. Hons. only)
5. Joint Honours in Psychology (Behavioural Neuroscience) and Biology (B.Sc. Hons. only)
6. Joint Honours in Psychology (Behavioural Neuroscience) and Biochemistry (B.Sc. Hons. only)
7. Joint Honours in Psychology (Behavioural Neuroscience) and Biochemistry (Nutrition) (B.Sc. Hons. only)

Details of the joint honours programs are given under the Degree Regulations of the Faculty of Science.

5.10.2 Admission to Major and Minor Programs

Admission to the Major and Minor programs in the Department of Psychology is competitive and selective. Students who wish to enter these programs must submit a completed application form to the Psychology Department by June 1 for Fall semester registration and by October 1 for Winter semester. To be eligible for admission, students must have completed the 24 credit hours as listed below with an average of at least 65% in Psychology 1000/1001 and an overall average of at least 60% in Psychology, English, and Mathematics:

1. Psychology 1000, 1001

2. English 1080 and one of 1101, 1102, 1103, or 1110, or equivalents.
3. Mathematics 1000, or two of 1090, 1050, 1051 (or equivalents).
4. Six credit hours of electives (9 if only Mathematics 1000 is completed).

Students who fulfill the eligibility requirements compete for a limited number of available spaces. Selection is based on academic performance, normally cumulative average and performance in recent courses.

5.10.3 Admission to Honours Programs

The Honours programs in the Department of Psychology are designed for students who would like to concentrate their studies or pursue graduate work. Students who wish to be admitted to these programs must submit an "Application for Admission to Honours Program Faculties of Arts or Science" to the Psychology Department by June 1 for Fall semester registration and by October 1 for Winter semester. To be eligible for admission, students must have completed Psychology 2910, 2911, 2520, and 2570 and obtained in these courses a grade of "B" or better, or an average of 75% or higher. Students who fulfill the eligibility requirements compete for a limited number of available spaces. Selection is based on academic performance in the required courses. In special circumstances, students may be admitted to Honours Programs at times other than June and October.

Note: Students are advised to consult the general regulations for Honours in the Faculty of Arts or the Faculty of Science, as appropriate.

5.10.4 Requirements for a Major in Psychology

1. Students may Major in Psychology as part of either a B.A. or a B.Sc. program. All Majors are required to complete a minimum of 42 credit hours of Psychology as listed below:
 - a. Psychology 1000, 1001, 2520, 2570, 2910, 2911
 - b. Twelve credit hours in Psychology chosen from the following: 3050, 3100, 3250, 3350, 3450, 3620, 3650, 3750, 3800 or 3801.
 - c. Twelve credit hours of 4000-level courses in Psychology, of which at least one must be a research experience course and one must be a selected topics course.
2. Psychology Majors following the B.Sc. program are also required to complete the following:
 - a. Mathematics 1000 (or equivalent).
 - b. Biology 1001 and 1002
 - c. Either Chemistry 1010 and 1011 (or 1050 and 1051); OR Physics 1020 (or 1050) and 1021 (or 1051)
 - d. Six credit hours of laboratory courses at the 2000 level or above in one of Biology, Chemistry, or Physics.

Note: Biology/Psychology 3750 and Biology/Psychology 4701 cannot be used to satisfy the requirement of 6 laboratory credit hours at the 2000 level or above in either Biology, Chemistry, or Physics.
3. Psychology Majors following the B.A. program are also required to complete Mathematics 1000 or two of 1090, 1050, 1051 (or equivalents), and are encouraged to complete at least 6 credit hours in Biology.

5.10.5 Requirements for Honours in Psychology

1. Honours students in Psychology are required to complete the 60 credit hours of Psychology as listed below:
 - a. Psychology 1000, 1001, 2520, 2570, 2910, 2911, 3900, 4910, 499A/B
 - b. Eighteen credit hours chosen from the alternatives listed in Clause 1. b. of the requirements for a Major in Psychology
 - c. Twelve credit hours of 4000-level courses in Psychology, of which at least one must be a research experience course and one must be a selected topics course.
2. Honours students must also complete the requirements listed in either Clause 2. or Clause 3., as applicable, of the requirements for a Major in Psychology.
3. Honours students will be required to submit in their graduating year, an undergraduate thesis (Psychology 499A/B) which demonstrates their competence in Experimental Psychology.

5.10.6 Requirements for a Major in Behavioural Neuroscience (B.Sc. Only)

A program is offered in the Psychology Department to provide an education in Behavioural Neuroscience. Students wishing to enroll in the program are advised to consult with the Head of the Department at the earliest opportunity. Students who intend to pursue graduate studies should take courses leading to the Honours degree.

The program for a Major in Behavioural Neuroscience shall include:

1.
 - a. Psychology 1000, 1001, 2520, 2570, 2910, 2911, 3800, 3801
 - b. Six credit hours in Psychology chosen from the following: 3050, 3100, 3250, 3350, 3450, 3620, 3650, 3750.
 - c. Six credit hours of 4000 level courses in Psychology, of which one must be a research experience course.
2.
 - a. Mathematics 1000 (or equivalent) and 1001
 - b. Chemistry 1010 and 1011 (or 1050 and 1051), and 2440 (or 2400/2401)
 - c. Physics 1020 (or 1050) and 1021 (or 1051).
 - d. Biology 1001 and 1002
 - e. English 1080 and one of 1101, 1102, 1103, or 1110, or equivalents
3. Eighteen credit hours from the following courses chosen from at least three different sciences:
 - a. Biochemistry: Any 2000-, 3000-, or 4000-level course except 2000, 2010, 2011, 3202, 3402, or 4502
 - b. Biology: 2060, 2210, 2250, 2900, 3050, 3160, 3202, 3295, 3401, 3500, 3530, 3540, 3750, 4200, 4241, 4245, 4250, 4402, 4450, 4601, 4605, 4701, 4900 (see note below)
 - c. Chemistry: 2210, 2300 or any 3000 or 4000 level course
 - d. Computer Science: Any 2000, 3000, or 4000 level course except 2650 and 2801
 - e. Mathematics: 2000, 2050, 2051, 3000, 3001 or any 3000 or 4000 level pure or applied mathematics course
 - f. Physics: Any 2000, 3000, or 4000 level course except 2151, 3150, 3151

Notes: 1. Credit may not be obtained for both Biology 3750 and either Psychology 3750 or Psychology 4770, or for both Biology 4701 and Psychology 4701.

2. The courses listed under Clause 3 may have prerequisites. It is the student's responsibility to ensure that all prerequisites have been met, or that waivers have been obtained, before registering for these courses.

5.10.7 Requirements for Honours in Behavioural Neuroscience (B.Sc. Only)

- Honours students in Behavioural Neuroscience are required to complete the following Psychology courses: 1000, 1001, 2520, 2570, 2910, 2911, 3800, 3801, 3900, 499A/B, two further courses in Psychology chosen from the following: 3050, 3100, 3250, 3350, 3450, 3620, 3650, 3750; two 4000 level courses in Psychology of which one must be a research experience course.
- Honours students in Behavioural Neuroscience must also complete the requirements listed in Clauses 2. and 3. of the requirements for a Major in Behavioural Neuroscience.
- In accordance with Clause 6. a. of the Regulations for the Honours Degree of Bachelor of Science, Honours candidates must obtain a grade of "B" or better, OR an average of 75% or higher in all the required courses listed in Clauses 1. and 3. of the requirements for a major in Behavioural Neuroscience and Clause 1 of the requirements for honours in Behavioural Neuroscience, except those at the 1000 level.

5.10.8 Requirements for a Minor in Psychology

Students who Minor in Psychology are required to complete a minimum of 24 credit hours of Psychology as follows:

- Psychology 1000, 1001, 2520, 2570
- Twelve other credit hours of Psychology.

5.10.9 Course Descriptions

In accordance with Senate's *Policy Regarding Inactive Courses*, the course descriptions for courses which have not been offered in the previous three academic years and which are not scheduled to be offered in the current academic year have been removed from the following listing. For information about any of these inactive courses, please contact the Head of the Department.

5.10.9.1 Non-Restricted Courses

Note: *These courses are open to all students who have the appropriate prerequisites. Psychology 1000 and 1001 are prerequisites for all Psychology courses. Students who intend to major in Psychology should note that each course marked with an asterisk is credit-restricted with a Majors laboratory course; consequently, taking these courses will reduce your options in the Majors program.*

1000 and 1001 Introduction to Psychology is an introduction to Psychology as a biological and social science. Topics shall include research methodology, physiological processes, perception, learning, memory and cognition, human development, animal behaviour, emotion, motivation, consciousness, personality and individuality, psychological disorders and treatment, and social psychology.
Psychology 1000 is a prerequisite for Psychology 1001.

2010 The Psychology of Human Development I* is a survey of principles underlying human development from the prenatal stage to adolescence. Topics covered will include sensorimotor, linguistic, perceptual, cognitive and motivational changes.
Prerequisites: Psychology 1000 and 1001.
Note: *Credit may not be obtained for both Psychology 2010 and either of the following: Psychology 3050, Psychology 2025.*

2011 The Psychology of Human Development II is an examination of relevant research on socialization and personality development with special emphasis on attachment, imitation, sex role and moral development in childhood and adolescence.
Prerequisites: Psychology 1000 and 1001.
Note: *Credit may not be obtained for both Psychology 2011 and Psychology 2025.*

2012 The Psychology of Human Development III is concerned with the major physical, intellectual and interpersonal changes associated with maturity and aging. It completes the study of the life-span development of the human organism initiated in Psychology 2010 and 2011.
Prerequisites: Psychology 1000 and 1001.
Note: *Credit may not be obtained for both Psychology 2012 and Psychology 3052.*

2100 Attitudes and Social Cognition* is an examination of the concepts and principles involved in the interaction between the individual and others. Emphasis will be on the theoretical and empirical concerns of attitude formation and change, social perception, and social cognition.
Prerequisites: Psychology 1000 and 1001.
Note: *Credit may not be obtained for both Psychology 2100 and either of the following: Psychology 3100, Psychology 2125.*

2120 Interpersonal and Group Processes - inactive course.

2150 Introduction to Forensic Psychology will provide an in-depth overview of the relationship between psychology and the law. A variety of topics will be discussed and critically evaluated, including the use and misuse of psychology-based investigative methods such as offender and geographic profiling, detection of deception, investigative interviewing, eyewitness testimony, jury decision-making, corrections and treatment, risk assessment, and criminal responsibility.
Prerequisites: Psychology 1000 and 1001.

2240 Survey of Learning - inactive course.

2440 Human Memory and Cognition* is an introduction to the basic principles of human memory and information processing. Topics covered will include the organization, representation and retrieval of information in memory, attention, pattern recognition, language processing, mental imagery, reasoning, problem solving, and decision making. There will be an emphasis on the application of basic principles to real life situations.
Prerequisites: Psychology 1000 and 1001.

Note: *Credit may not be obtained for both Psychology 2440 and any of the following: Psychology 3450, Psychology 4662, Psychology 2425.*

2530 Mathematical Psychology - inactive course.

2540 Psychology of Gender and Sex Roles is an examination of the influence of gender and sex roles on development and socialization, attitude formation, cognition, personality and mental health.

2560 Intelligence - inactive course.

2610 Personality* is a review of the research and theory pertaining to a psychological understanding of human personality.
Prerequisites: Psychology 1000 and 1001.
Note: *Credit may not be obtained for both Psychology 2610 and any of the following: Psychology 3620, Psychology 2625, the former Psychology 2620.*

2800 Drugs and Behaviour is an examination of the neurophysiology of drug action, the measurable effect of drugs on experimentally controlled behaviour, and a survey of information available on common self-administered drugs and their immediate and long-term effects.
Prerequisites: Psychology 1000 and 1001.

2810 Brain and Behaviour* is a broad survey of physiological psychology at an elementary level. Topics will include the following: structure of the nervous system, nerve conduction, sensory and motor systems, behavioural biology of reproduction, aggression, feeding and drinking, sleep and arousal, pleasure and pain, learning and memory.
Prerequisites: Psychology 1000 and 1001.
Note: *Credit may not be obtained for both Psychology 2810 and any of the following: Psychology 3801, Psychology 2825, the former Psychology 2850.*

3430 The Psychology of Thinking will present theories and experimental studies of problem solving, creativity and decision making. Topics covered will include the difficulties encountered in problem solving and solutions such as strategies for organizing and representing information, the production of ideas, transfer and discovery learning.
Prerequisites: Psychology 1000 and 1001.
Note: *Credit may not be obtained for Psychology 3430 and the former Psychology 2430.*

3501 Industrial Psychology is an examination of the theories and concepts of industrial psychology. Topics covered will include research and testing methods, measuring job and performance appraisal systems, personnel selection methods, personnel training and development, work motivation, work stress, designing work for people, and human engineering.
Prerequisite: Any 2000-level course in Psychology.

3533 Sexual Behaviour is a psychological analysis of sexual behaviour. The course will examine the physiological, behavioural, social and personality bases of the male and female sexual response, heterosexuality and homosexuality and other sexual behaviour. Other topics may include the social precursors of human sexual behaviour, sex therapy, pregnancy and childbirth, and nonhuman sexual behaviour.
Prerequisites: Psychology 1000 and 1001.
Note: *Credit may not be obtained for Psychology 3533 and the former Psychology 3300.*

3577 Program Evaluation - inactive course.

3640 The Psychology of Abnormal Behaviour* covers problems of definition, the history of beliefs about abnormal behaviour and the

implication of a behavioural model for the understanding and control of behaviour problems will be discussed.

Prerequisite: Any 2000 level course in Psychology.

Note: *Credit may not be obtained for both Psychology 3640 and any of the following: Psychology 3650, Psychology 3626, and the former Psychology 3600.*

4810 Human Neuropsychology covers clinical disorders of sensation, perception, movement, memory, language and emotion that have resulted from brain damage or disease from the perspective of current knowledge of brain structure and function. Lateralization of function, disconnection syndromes, and mechanisms of recovery of function following brain damage will also be covered. Related experimental studies of brain structure and function in non-humans will be discussed.

Prerequisite: One of Psychology 2810, 3800 or 3801 (formerly 2850).

5.10.9.2 Majors Courses

Note: *These courses are restricted to Majors and Minors in Psychology and Behavioural Neuroscience.*

2520 Mind and Brain covers cognitive and neuroscience perspectives on two different themes (visual perception from sensation through imagery, attention and working memory) will be used to convey the logic and methods used in modern-day psychological research, the development and use of theory to guide further research, the utility of multiple research perspectives for developing a full understanding of psychological issues, and basic concepts in cognition and neuroscience.

Prerequisites: Psychology 1000 and 1001.

2570 Understanding Individual Differences uses current conceptualizations of personality and ability as a focus, the course will review issues related to the measurement of individual differences, including test characteristics and ethics. Research from a variety of perspectives will be used to illustrate the contributions of different areas of psychology to our understanding of individual differences.

Prerequisites: Psychology 1000, 1001.

2910 Research Methods in Psychology I is an introduction to the design and application of psychological research with particular concentration on understanding and applying scientific method, creating and testing hypotheses, constructing reliable and valid experiments, managing and analyzing data sets, using statistical software, and scientific writing. Specific topics include descriptive statistics including measures of central tendency, variability and relative standing, inferential statistics such as *t* tests for one and two sample designs, correlation and regression, and non-parametric statistics.

Prerequisites: Psychology 1000 and 1001; Mathematics 1000 or two of 1090, 1050 and 1051 (or equivalents)

Laboratory period weekly.

Note: *Credit may not be obtained for both Psychology 2910 and any of the following: Statistics 2500, 2510, 2550, Psychology 2900, 2925.*

2911 Research Methods in Psychology II covers research methods in psychology with a focus on more complex research designs and statistical approaches, within the realm of experimentation and beyond the laboratory. Specific topics include controlling participant variables, using between and repeated measures designs within the context of Analysis of Variance (ANOVA). Particular ANOVA approaches include one-way and factorial designs, within subject design, and two-way mixed designs.

Prerequisite: Psychology 2910

Laboratory period weekly.

Note: *Credit may not be obtained for both Psychology 2911 and any of the following: Statistics 2501, 2560, Psychology 2901, 2950.*

3050 Developmental Psychology is an examination of the methods of study and an evaluation of current findings and theoretical issues of importance to an understanding of development. Topics will be drawn from perception, learning, cognition, social learning, memory and language development.

Prerequisite: Psychology 2520, 2570 and 2911.

Note: *Credit may not be obtained for both Psychology 3050 and Psychology 2010.*

3100 Social Psychology is an examination of the concepts and principles involved in social behaviour. Topics covered will include attitudes, social cognition, interpersonal relations, and group processes.

Prerequisite: Psychology 2520, 2570, and 2911.

3250 Learning (formerly 2250) examines how organisms adjust their behaviour to regularities in the environment as a result of experience.

Prerequisites: Psychology 2520, 2570, and 2911.

Note: *Credit may not be obtained for both Psychology 3250 and Psychology 2225 or the former Psychology 2250.*

3350 Perception (formerly 2360) is a broad survey of theory and research in sensation and perception.

Prerequisites: Psychology 2520, 2570 and 2911.

Note: *Credit may not be obtained for both Psychology 3350 and the former Psychology 2360.*

3450 Human Cognition is an introduction to the experimental study of the mental representations and processes involved in human cognition. Topics such as attention, perception and pattern recognition, concepts and the organization of knowledge, language processes, mental imagery, reasoning, problem solving, decision making and skilled performance will be covered

with an emphasis on experimental analysis and techniques.

Prerequisite: Psychology 2520, 2570 and 2911.

Note: *Credit may not be obtained for both Psychology 3450 and either of the following: Psychology 2440, Psychology 2425.*

3620 Personality Theory and Research is a survey of personality theory and research.

Prerequisites: Psychology 2520, 2570 and 2911.

Note: *Credit may not be obtained for both Psychology 3620 and any of the following: Psychology 2610, Psychology 2625, and the former Psychology 2620.*

3650 Abnormal Psychology is an examination of the nature, explanation and treatment of psychological disorders with an emphasis on research methods and current findings.

Prerequisites: Psychology 2520, 2570 and 2911.

Note: *Credit may not be obtained for both Psychology 3650 and either of the following: Psychology 3640, Psychology 3626.*

3750 Animal Behaviour I is an introduction to the mechanisms, development, function and evolution of behaviour in animals. Topics include the history of ethology and comparative psychology, and behavioural ecology; methods of animal behaviour study, behaviour of animals in relation to physiology, learning, communication, mating systems, and other areas in Biology and Psychology.

Prerequisites: Biology 1001, 1002 and Psychology 2520, 2570 and 2911.

Note: *Credit may be obtained for only one of Psychology 3750 and Biology 3750.*

3800 Neuroscience addresses the structure and function of neurons and neural circuits and examines principles of electrochemical neural communication at the macroscopic, microscopic and molecular level. The relevance of this knowledge to understanding brain mechanisms of normal and diseased brain functions will be touched upon. The molecular basis of the formation of some types of memories will be explored.

Prerequisite: Psychology 2520, 2570 and 2911.

3801 Behavioural Neuroscience is a survey of knowledge about brain mechanisms of behaviour. Topics will include the following: basic neuroanatomy and neurophysiology, somatosensory systems and pain, reward, mental illness, sleep and arousal, developmental neurobiology, sexual development and behaviour, regulation of eating and body weight, learning and memory, and cortical function, including cortical mediation of language.

Prerequisite: Psychology 2520, 2570 and 2911.

Note: *Credit may not be obtained for both Psychology 3801 and any of the following: Psychology 2810, Psychology 2825, the former Psychology 2850.*

3900 Design and Analysis III is a course on complex and specialized research design in Psychology. Multifactor research designs that employ both between- and within-subjects independent variables. Advantages and disadvantages of using multifactor research designs to test psychological hypotheses. Hierarchical designs and incomplete factorials. The use of covariates and blocking to increase experimental precision. Problems created by missing data. Single subject designs. How to answer specific psychological questions in the context of complex designs. The design and analysis of non-experimental psychological research. Applications of such techniques as the analysis of variance and multiple linear regression to the data obtained with these research designs, with special attention to problems inherent in psychological research.

Prerequisite: Psychology 2911.

Laboratory period weekly.

Note: *Credit may not be obtained for both Psychology 3900 and any of the following: Psychology 3950, Statistics 3520.*

4050 Selected Topics in Developmental Psychology I

Prerequisite: Psychology 3050 or 3051.

4051 Selected Topics in Developmental Psychology II

Prerequisite: Psychology 3050 or 3051.

4070 Research Experience in Development Psychology allows students to gain research experience in selected areas of developmental psychology.

Prerequisites: Psychology 2520, 2570, 2911, and 3050.

4150 Selected Topics in Social Psychology I

Prerequisite: Psychology 3100 or the former Psychology 3160.

4151 Selected Topics in Social Psychology II

Prerequisite: Psychology 3100 or the former Psychology 3160.

4152 Selected Topics in Applied Social Psychology

Prerequisite: Psychology 3100 or the former Psychology 3160.

4160 Psychology and the Law allows students, upon completion of this course, to demonstrate an advanced understanding of psychology and the law. Specifically, students will be able to discuss and critically evaluate topics related to the Canadian legal system, police investigations, memory in legal contexts, jury selection, jury decision-making, sentencing, parole, offender assessment and treatment, fitness to stand trial, and forensic civil psychology.

Prerequisite: Psychology 3100 or the former Psychology 3160.

4170 Research Experience in Social Psychology will provide research experience in a selection of areas typically studied by social psychologists

such as attitudes, prejudice, groups and social cognition. Students will acquire experience with research methods that are used to advance the body of knowledge in social psychology.

Prerequisites: Psychology 2520, 2570, 2911, and 3100.

4250 Selected Topics in Learning and Motivation I

Prerequisite: Psychology 3250 or the former Psychology 2250.

4251 Selected Topics in Learning and Motivation II

Prerequisite: Psychology 3250 or the former Psychology 2250.

4260 Learning Processes and Drug Effects focuses on explanations of the behavioural effects of drugs that can be found in learning and conditioning theory. This course will provide a careful examination of such processes as drug state conditioning and discrimination, drug effects on operant behaviour, drug self-administration and tolerance.

Prerequisite: Psychology 3250 or the former Psychology 2250.

4270 Research Experience in Learning allows students to gain research experience in selected areas of learning.

Prerequisites: Psychology 2520, 2570, 2911, and 3250.

4350 Selected Topics in Perception I is an intensive examination of a specific topic of current interest in perception.

Prerequisite: Psychology 3350 or the former Psychology 2360.

4351 Selected Topics in Perception II is an intensive examination of a specific topic of current interest in perception.

Prerequisites: Psychology 3350 or the former Psychology 2360.

4370 Research Experience in Perception allows students to gain research experience in selected areas of perception.

Prerequisites: Psychology 2520, 2570, 2911 and 3350.

4400 Selected Topics in Cognition I

Prerequisite: Psychology 3450.

4401 Selected Topics in Cognition II

Prerequisite: Psychology 3450.

4402 Selected Topics in Cognitive Science provides an in-depth examination of current issues in cognitive science from a psychological perspective.

Prerequisites: Two courses from Psychology 3050, 3250, 3350, 3450, 3801.

4452 Selected Topics in Cognition: Reading is a survey of the research literature on the development of reading skills including a discussion of dyslexia.

Prerequisites: Psychology 3450 and a course in Linguistics.

4461 Psycholinguistics (formerly 3400) is the psychological approach to the study of language concentrating particularly on the areas of speech, meaning, grammar and communication. The research topics to be discussed include the child's acquisition of language, bilingualism, teaching language to animals, and social factors in language use.

Prerequisites: Psychology 3050 or 3450.

4462 Human Memory surveys theories and research about how humans remember information and why they forget. Topics include research on sensory memory, short-term working memory, amnesia, forgetting, memory development, and semantic memory as well as practical issues such as how to improve memory.

Prerequisite: Psychology 3450.

4470 Research Experience in Cognition allows students to gain research experience in selected areas of cognition.

Prerequisites: Psychology 2520, 2570, 2911, and 3450.

4610 Selected Topics in Personality I

Prerequisite: Psychology 3620 or the former Psychology 2620.

4620 Selected Topics in Personality II

Prerequisite: Psychology 3620 or the former Psychology 2620.

4650 Selected Topics in Abnormal Behaviour I

Prerequisite: Psychology 3650.

4651 Selected Topics in Abnormal Behaviour II

Prerequisite: Psychology 3650.

4660 Developmental Psychopathology is a review of current theory and research related to the developmental course of maladaptive behaviours in children and adolescents. Topics will include behavioural, emotional and developmental disorders. Research concerning the role of individual, family, community and cultural factors will be discussed.

Prerequisite: Psychology 3650.

4661 Family Psychology is a study of the reciprocal relationship between family processes and abnormal behaviour. The course will focus on the role of family dynamics in the etiology of abnormal behaviour, the impact of psychological disorders on family functioning and the application of family therapy to create therapeutic change.

Prerequisite: Psychology 3650, or all of 2520, 2570, 2911 and 3640.

4662 Clinical Psychology and Theories of Psychotherapy will introduce students to the science and profession of clinical and counselling psychology. Course content will include a review of approaches to assessment and psychotherapy and a look at some of the major research questions and findings in this area.

Prerequisite: Psychology 3650.

4670 Research Experience in Abnormal Psychology allows students to gain research experience in selected areas of clinical psychology.

Prerequisites: Psychology 2520, 2570, 2911 and 3650.

4671 Research Experience in Personality allows students to gain experience in selected areas of personality research.

Prerequisites: Psychology 2520, 2570, 2911 and 3620.

4701 Animal Behaviour II - inactive course.

4750 Selected Topics in Animal Behaviour I will examine in detail a specific topic of current interest in animal behaviour.

Prerequisite: Psychology 3750; or Biology 3750.

4751 Selected Topics in Animal Behaviour II

Prerequisite: Psychology 3750; or Biology 3750.

4770 Research Experience in Animal Behaviour allows students to gain research experience in selected areas of animal behaviour.

Prerequisite: Psychology 2520, 2570, 2911 and 3750.

4850 Selected Topics in Behavioural Neuroscience I

Prerequisite: Psychology 2810, 3800 or 3801.

4851 Selected Topics in Behavioural Neuroscience II

Prerequisite: Psychology 2810, 3800, or 3801.

4870 Neuroscience Research allows students to gain research experience in selected areas of neuroscience.

Prerequisites: Psychology 2520, 2570, 2911, and either 3800 or 3801.

4910 Systems in Contemporary Psychology is a study of paradigms and explanations in contemporary psychology in the context of their historical antecedents.

Prerequisite: Thirty credit hours in Psychology courses required in the majors program.

499A and 499B Honours Dissertation is a 6 credit hours linked course, based on independent study of an approved problem in Psychology. The topic will be chosen in consultation with the Faculty Advisor. The first semester will normally involve directed reading in this area, and preparation of a dissertation proposal. The second semester will be devoted to conducting the study, gathering data, data analysis and preparation of a formal written report. The dissertation must be submitted for grading before the end of the tenth week of the semester in which the student is registered for 499B.

Prerequisite: Admission to the Honours Program.

5.11 Science

1000 Introduction to Science I is a liberal science course for Arts students, which reflects the way scientists think and work through historical, philosophical and social considerations of the environment we live in. Typical course content includes: the concepts of matter, motion and energy; the chemical basis for life and the interdependence of organisms; and the abundance and distribution of the Earth's natural resources.

Three lectures a week.

No laboratory.

1001 Introduction to Science II is continuation of Science 1000.

Prerequisite: Science 1000.

Note: *Science 1000/1001 may not be used to fulfill any of the Science course requirements for the Honours and General Degrees in Science.*

1150 and 1151 Introduction to Physical and Life Sciences (formerly Science 115A/B) (1150 (F) and 1151 (W)) is an introduction to some concepts in the Physical and Life Sciences. These courses are primarily intended for the non-science major (B.A.; B.Ed. (Primary/ Elementary)).

Note: *Science 1150 and 1151 are not acceptable as prerequisites for 2000 level courses in Physics, Chemistry, Biology, Geography or Earth Sciences. Credit may not be obtained for both Science 115A and Science 1150 or for Science 115B and Science 1151.*

5998 Exchange Programs in Science will be available only to students attending Memorial University of Newfoundland as part of a formal exchange agreement, memorandum of understanding, or other special arrangement. Admission is by permission of the Dean of Science. Credit hours: 3 - 15, to be determined for each offering by the Dean in consultation with the appropriate Head of Department or Co-ordinator. This course may be repeated for credit once. This course will normally be offered twice a year, from March to August and September to February.

