COUNCIL OF THE FACULTY OF SCIENCE

NOTICE OF MEETING

October 10, 2023

3pm – 4:30pm

via Zoom

AGENDA

1. Call to Order and Approval of Agenda
2. Chair's Remarks
3. Approval of September 12, 2023 Minutes
4. Business Arising
5. Inquiries and Communications
   > September 28, 2023 Senate Synopsis
6. Dean's Remarks
7. Associate Dean and Head of Bethune College Remarks
8. Reports from Science Representatives on Senate Committees
9. Report from Student Caucus Representative
10. Reports from Standing Committees of Council
    a) Executive Committee:
    > Ratification and Call for Nominations for Senate and Standing Committee of Council
    > Vacancies report on the Standing Committees of FSc Council
    b) Undergraduate Curriculum Committee:
    > Consent agenda items

    Other Business

    a) Office of Sustainability Fall update and opportunities to shape York's Action on Sustainability – Mike Layton, Chief Sustainability Officer

COUNCIL OF THE FACULTY OF SCIENCE

MINUTES

September 12, 2023

3pm – 4:30pm

LUM 306

AGENDA

1. **Call to Order and Approval of Agenda**
   N. Kovinich, Chair of Council called the meeting to order and a motion was moved, seconded and carried to approve the Agenda as presented.

2. **Chair's Remarks**
   Chair of Council N. Kovinich welcomed members of council and confirmed the delivery format of Faculty Council meetings this academic year: September and May meetings will be held in person and October – April meetings will be held virtually.

3. **Approval of May 9, 2023 Minutes**
   A motion was moved, seconded and carried to approve the Minutes with two minor changes: include the missing May 9 attendance and remove duplicate "5." on page 1.

4. **Business Arising**
   There was none.

5. **Inquiries and Communications**
   > May 25, 2023 Senate Synopsis
   Council members noted the Senate Synopsis of meeting held on May 5, 2023.
   > June 29, 2023 Senate Synopsis
   Council members noted the Senate Synopsis of meeting held on June 29, 2023.

6. **Dean's Remarks**
   Dean Wang welcomed Council to the new academic year.

   Congratulations:
   Department of Biology having the second most popular program at York University.

   Thank You:
   Strategic Enrolment team and the Science Academic Services team for their dedication to meeting and exceeding targets. He introduced Eva Hughes, the new

Assistant Dean, Strategic Enrolment Management & Science Engagement Program.

IT Team creating several new webpages and handling hundreds of tickets over the summer.

Events:
95 members of the Faculty of Science were in attendance for the Annual Summer BBQ at the Orange Snail on August 30.

Upcoming:
Visiting Mumbai, India on September 14 – 25 in Collaboration with Foundation of Medical Research AI centre in to build partnership and recruitment.

7. Associate Dean and Head of Bethune College Remarks

Associate Dean Students, M. Scheid:
Shared a presentation on the Fall 2023 enrollment in comparison to 2019 – 2022, emphasizing the enrollment success of this academic year.

Associate Dean Research & Partnerships, V. Saridakis:
Shared a presentation and highlighted the Undergraduate Student Summer Research Conference, grant application deadlines and contact information.

Associate Dean Research & Partnerships, V. Saridakis on behalf of Faculty Affairs, G. Audette:
Retirement call emails will be sent out this week.

Associate Dean Curriculum and Pedagogy, H. Kouyoumdjian:
Shared a presentation explaining the initiatives such as WebWork, Open Educational Resources, EDI focused slides, syllabi and courses.

Invited faculty members to an Exploring Open Education in the Sciences virtual workshop on September 28 at 2pm – 4pm.

8. Reports from Science Representatives on Senate Committees

There was none.

9. Report from Student Caucus Representative

There was none.

10. Reports from Standing Committees of Council

a) Executive Committee:

> Ratification and Call for Nominations for Senate and Standing Committee of Council

A motion was moved, seconded and carried to ratify all nominations to the Standing Committees of Council.

> Vacancies report on the Standing Committees of FSc Council

N. Kovinich noted the vacancies that remain.

b) Committee on Equity, Diversity and Inclusivity:

> Annual Report

c) Committee on Teaching & Learning:

> Annual Report

d) Graduate Curriculum Committee:

> Annual Report

> GS/BIOT & GS/PHYS consent agenda items

e) Research and Awards Committee:

> Annual Report

f) Senate T & P Review Committee:

> Annual Report

11. Other Business

a) Student Services – Nona Robinson, Vice-Provost Students & Yukimi Henry, Executive Director, Community Support & Services

VPS Nona Robinson and Yukimi Henry (ED Community Supports & Services provided a presentation on student services and how DoS can support with referrals and resources with an emphasis on students of concern and in some cases distressing issues, and/or managing serious behavioural student issues.

Meeting Adjournment

A motion was moved, seconded and carried to adjourn the meeting.

The Senate of York University

Synopsis

The 698th Meeting of Senate held on Thursday, 28 September 2023

Remarks

In the absence of the Chair, Poonam Puri, Vice-Chair, Lauren Sergio presided over the meeting, as acting Chair, and Senator Patricia Burke Wood was acting Vice-Chair.

The Chair expressed thanks to new and returning members who attended the orientation session just before the meeting.

Inquiries and Communications

Senator van Wijngaarden delivered highlights from the report of the academic Colleague to COU. The full report is included in the document package.

Reports

Under President's items, President Lenton spoke to the following:

- Trip to India with Deans, to build and nurture linkages with international partners
- Audit update: meeting with the Auditor General of Ontario on the preliminary factual report document; the draft report from the Auditor is expected mid-October; the report will be tabled with the Ontario legislature in November
- The challenges resulting from a shortfall in international student enrolments for FW'23, a continued tuition fee freeze and additional economic pressures, and the significant cumulative impact on the University's operating budget.
- Candidates for Honorary Degrees at Fall convocation are:
    - Mr. Nnimmo Bassey: environmental justice activist, author, architect, poet
    - Mr. Wes Hall: Entrepreneur, philanthropist, community leader
    - Mr. Andromache Karakatsanis: supreme court justice, philanthropist
    - Ms. Itha Sadhu: educator, author, historian, community developer

The President's monthly "Kudos" report on the achievements of members of the York community was received.

Approvals

Senate approved upon recommendation by the Executive Committee the election of members to the non-designated Senate Committees of Appeals, Awards, Tenure & Promotions, and the Joint Sub-committee on Quality Assurance.

The Senate of York University Synopsis

Committee Information Reports

Executive Committee

The Chair, highlighted:

- the recently approved new/revised members on the Faculty-designated and non-designated Senate committees, adding the additional approval of Andrea Davis as the LA&PS designated member on APPRC as confirmed through an e-vote of Executive
- The Senate meeting schedule for this year, both the dates and modes of delivery

Academic Policy, Planning and Research Committee (APPRC)

The Chair of APPRC, Senator Davis, described APPRC's role and relationship to Senate and how it fulfills its mandate, and spoke briefly to the written report circulated with the agenda.

Academic Standards, Curriculum and Pedagogy Committee (ASCP)

The Chair of ASCP, Senator Michasiw described ASCP's role and key priorities for 2023-2024.

Senate Appeals Committee (SAC)

The Chair of SAC, Senator Sutherland spoke to the Appeal Committee's mandate and role.

Awards Committee

The Chair of Awards, Senator Bashir described the Committee's mandate.

Tenure and Promotions Committee (T&P)

The Chair of T&P, Senator Bohn described T&Ps role and mandate, and reiterated the critical need for faculty members to serve on the Committee to allow for the continuing review of applications, without interruption, asking Senators to convey the call to their units and Faculties.

Other Business with Due Notice Received

Senate approved the following substantive motion, authorized by Senate Executive:

- That Senate provide accommodation to students who participate in the national *Day of Action* against rising tuition fees to be held on Wednesday, 8 November 2023; and
- That faculty members be asked through the Deans / Principal to establish reasonable extensions of deadlines for graded work due on that date, and to provide reasonable academic accommodations to students who participate in the

event, including reasonable alternative access to materials covered during their absence that does not alter the academic standards with the missed activity.

Additional Information about this Meeting

Please refer to the full Senate agenda and supplementary material posted online with the **28 September 2023** meeting for details about these items.

https://www.yorku.ca/secretariat/senate/meeting-agendas-and-synopses/

Senate's next meeting will be held at **3:00 pm on Thursday, 26 October 2023.**

FACULTY COUNCIL
SIGN-IN SHEET

science | YORK UNIVERSITÉ UNIVERSITY

NOTICE OF MEETING

September 18, 2023

3pm – 4:30pm

LUM 306

SIGN IN:

NAME	SIGNATURE
R WANG	
Hovig Kouyoumdjian	
NIK KOVINICH	
Derek Jackson	
Ryan Hili	
Robert Tsushima	
Hugo Chen	
JERUSHA LIEBERMAN	
Tamara Kelly	
Ivan Wijnaadts	
Tom Kirchner	
Jamie Chuck	
VERA PAURI	
ROBIN MERCURE	
Boris von Rensburg	
NEAL MADRAS	
Pat Lakin-Thomas	
Wendy Booth	
Trevor Vandenberg	
Christine	

HELEN ABRAHAM	
Massi La	
EVA HUGHES	
Pat Hall	
Mingming Li	
Jade Abellah	
Farnaz Mansouri-Nouri	
Violeta Gotcheva	
Tanya DeSylva	
Helen McLellan	

2023-2024 FSc Report on vacancies for Senate and FSc Standing Committees of Council

RATIFICATION OF NOMINATIONS

Committee on Examinations and Academic Standards:
J. Sapp, Department of Biology (term 2023 – 2026)

Senate:
Terry Kubiseski, Department of Biology (term 2023 – 2026)

SRC T & P Committee:
D. Bazely, Department of Biology (term 2023 – 2026)

Committee on Teaching and Learning:
T. Kelly, Department of Biology (term 2023 – 2026)

Appeals:
L. Donaldson, Department of Biology (term 2023 – 2026)

Undergraduate Student Nominations for 2023-2024 Faculty Council:
Adriano Tersigni
Ailiya Rizwna
Ali Bashar
Claire Del Zotto
Hemish Ahuja
Julia Tersigni
Kirti Kamlesh Vaswani
Lomesh Choudhary
Madeline Blanco
Mustafa Abdulkadhim
Natalie Moussa
Ruella Ella Ordinaria
Sara Jazaeihaghighi
Sathyanarayanan Venkatesan
Satyam Verma
Seerat Choudhry
Shon Lazarev
Taline Apelian-Sutor
Yashna Manek
Yuna (Aria) Hwang

2023-2024 FSc Report on vacancies for Senate and FSc Standing Committees

Committee	Rules of Faculty Council - membership	Meeting time / Membership	Term	
			From	To
Senate	According to the York University Secretariat based on the Senate Rules and Procedures governing the size and composition of Senate, the Faculty of Science shall have twelve members, including a minimum of two Chairs. According to The Rules of Council (Science), Faculty representation shall include the Director of Natural Science, three Department Chairs, and terms shall be for three years.	As per Senate website		
	Dean, Ex officio	R. Wang	Designated	
	Member at large	G. Audette	Designated	
	Member at large	William van Wijngaarden, Physics & Astronomy	2023	2024
	Member at large	EJ Janse van Rensburg, Mathematics & Statistics	2022	2025
	Member at large	T. Baumgartner, Chemistry	2021	2024
	Member at large	J. Elwick, Science, Technology & Society	2022	2025
	Member at large	T. Kubiseski, Biology	2023	2026
	Member at large	V. Saridakis, Biology	2021	2024
	Department Chair	V. Pavri, Department of Science, Technology & Society	2021	2024
	Department Chair	R. Tsushima, Department of Biology	2021	2024
	Department Chair	M. Haslam, Department of Mathematics & Statistics	2023	2026
	Director of NATS	R. Metcalfe, Dvision of Natural Science	Designated	
	Student representative	VACANT	2023	2025
	Student representative	Madeline Blanco	2022	2024
Faculty Council	Chair of Council	N. Kovinich	2023	2024
Staff Representatives	Vice-Chair of Council	M. Yousaf	2023	2024
		W. Booth	2023	2024
		D. Hossain	2023	2024
		W. Xu	2023	2024
FSc Reps on Senate Committees				
Senate Executive	1 member from FSc	T. Baumgartner	2021	2024
Academic Policy, Planning and Research Committee (APPRC)	1 member from FSc	G. Monette	2023	2026
ASCP (Academic Standards, Curriculum and Pedagogy Committee)	1 member from FSc	Mary-Helen Armour	2021	2024
Sub-Committee on Honorary Degrees & Ceremonials	1 member from FSc	VACANT	2023	2026
Executive Committee	The Executive Committee shall be chaired by the Chair of Council and include the Vice-Chair of Council, the Secretary of Council, and one member elected from each of Biology, Chemistry, Mathematics & Statistics, Physics & Astronomy, and Science, Technology & Society/Natural Science, the Dean of the Faculty of Science (ex officio), one student member of Council, and one of the staff members elected to Council.	Executive Committee normally meets the first Tuesday of each month (September to May) from 3pm - 430pm		
	Chair of Council	N. Kovinich	2023	2024
	Vice-Chair of Council	M. Yousaf	2023	2024
	Dean, Ex officio	R. Wang	Designated	
	Asst. Dean - SEM & SEP	Eva Hughes	Designated	
	Staff representative	W. Booth	2023	2024
	Undergraduate Student Rep	VACANT	2023	2024
	Biology	M. Vicari	2023	2026
	Chemistry	D. Wilson	2022	2025
	Math & Stats	E. J Janse Van Rensburg	2022	2025
	Physics & Astronomy	T. Kirchner	2023	2024
	Science, Technology & Society	C. Douglas	2023	2026
APPC	The Academic Policy and Planning Committee shall include the Dean or designate (*ex officio*), the Master of Norman Bethune College and one member elected from each of Biology, Chemistry, Mathematics & Statistics, Physics & Astronomy, and Science, Technology & Society/Natural Science, one student member of Council, and one of the staff members elected to Council.	APPC will normally meet the last Thursday of each month (September to April) from 9:00 am - 10:30 am		
	Associate Dean, Faculty Affairs, Ex officio	G. Audette	Designated	
	Head of Bethune College	J. Amanatides	Designated	
	Undergraduate Student Representative	VACANT	2023	2024
	Elected staff representative	M. Xu	2023	2024
	Biology	R. Schott	2023	2026
	Chemistry	R. Fournier	2023	2026
	Math & Stats	P. Szeptycki	2023	2026
	Physics & Astronomy	E. Hessels	2023	2024
	Science, Technology & Society	S. Domenikos	2022	2025
Undergraduate Curriculum Committee	The Curriculum Committee shall include the Dean and an Associate Dean (ex officio), the Chair or nominee from each teaching Division or Department, three members elected by Council and two student members of Council.	The Curriculum Committee will normally meet every last Tuesday of each month (September to April) from 1:30 pm - 3:00 pm		
	Member at Large	J. Attalah	2023	2026
	Member at Large	VACANT	2023	2026
	Dean, Ex officio	R. Wang	Designated	
	Assoc Dean, Curriculum & Pedagogy, Ex officio	H. Kouyoumdjian	Designated	
	Undergraduate Student Rep	VACANT	2023	2024
	Undergraduate Student Rep	VACANT	2023	2024
	Biology	M. Vicari	2022	2025
	Chemistry	D. Jackson	2022	2025
	Math & Stats	M.W. Wong	2023	2026
	Physics & Astronomy	M. George	2021	2024
	Science, Technology & Society	R. Metcalfe	2022	2025
	Member at Large	L. Robertson	2023	2026

2023-2024 FSc Report on vacancies for Senate and FSc Standing Committees

Committee	Rules of Faculty Council - membership	Meeting time / Membership	Term	
			From	To
CEAS	The Committee on Examinations and Academic Standards shall consist of an Associate Dean (*ex officio*), five members elected by Council from each of Biology, Chemistry, Mathematics & Statistics, Physics & Astronomy and Science, Technology & Society/Natural Science, and one student member of Council.	CEAS will normally meet every alternate Wed / Thurs from 1:00 - 3:00 pm year round.		
	In addition to the above membership of the committee, Council shall elect an alternate member from each of the Departments specified above. The alternate member shall be the person polling the next highest number of votes to those elected to the committee from each Department. The alternate for the student member will be selected by the Science Student Caucus from one of its Members at Large. An alternate can only vote in the event that first elected members are not in attendance.			
	Associate Dean - Students, Ex officio	M. Scheid	Designated	
	Undergraduate Student Rep	VACANT	2023	2024
	Undergraduate Student Rep	VACANT	2023	2024
	Biology	J. Sapp / ALT. VACANT	2023/2021	2026/2024
	Chemistry	P. Johnson & T.Zeng / ALT T. Mirkovic	2023/2023	2026/2026
	Math & Stats	I. Moyles, N.Purzitsky / ALT. Y. Gao	2021/2022	2025/2025
	Physics & Astronomy	C. Storry & VACANT / ALT. E. Hyde	2023/2023	2024/2024
	Science, Technology & Society	J. Webb / ALT. S. Domenikos	2023/2023	2026/2026
Petitions	The Petitions Committee for the purpose of hearing student petitions shall consist of an Associate Dean (*ex officio*), six members of Council, and two student members of Council. The Committee may divide the workload by splitting the Committee membership into two panels of four people each. A quorum shall consist of either (a) two faculty voting faculty members and one student member or (b) three voting faculty members.	Each panel meets once a month on Wednesday or Thursday from 2:30 pm - 4:00 pm		
	Associate Dean, Ex officio	M. Scheid	Designated	
	Undergraduate Student Rep	VACANT	2023	2024
	Undergraduate Student Rep	VACANT	2023	2024
	Member at Large	S. Morin	2023	2026
	Biology	C. Jang	2022	2025
	Chemistry	R. Fournier	2022	2025
	Physics & Astronomy	S. Jerzak	2023	2024
	Math & Stats	D. Liang	2022	2025
	Science, Technology & Society	J. Rogerson	2022	2025
	Member at Large	A. Mills	2023	2026
SRC T & P Committee	The Committee on Tenure and Promotions shall consist of one currently tenured member from each of Biology, Chemistry, Mathematics & Statistics, Physics & Astronomy and Science, Technology & Society/Natural Science elected by Council, and one student member of Council. No member of the Committee shall be a member of another Tenure and Promotions Committee at any time during their tenure on this committee.	SRC T & P Committee will normally meet the last Friday of each month (September to May) from 9:00 am - 11:00 am in LUM 305B		
	In addition to the above membership of the committee, Council shall elect an alternate member from each of the Units mandated above. The alternate member shall be the person polling the next highest number of votes to those elected to the committee from each Department. The alternate for the student member shall be selected by the Science Student Caucus from one of its Members-at-Large on an annual basis. An alternate can only vote in the event that existing members are not in attendance.			
	Associate Dean - Faculty, Ex officio	G. Audette	Designated	
	Undergraduate Student	VACANT	2023	2024
	Biology	D. Bazely / ALT. M. Bayfield	2023/2023	2026/2026
	Chemistry	A. Orellana/ ALT. D. Ifa	2023/2023	2026/2026
	Physics & Astronomy	M. Horbatsch /ALT. C. Bergevin	2023/2023	2024/2024
	Math & Stats	Y. Gao / ALT Jianhong Wu	2021/2022	2024/2025
	Science, Technology & Society	E. Hamm / ALT. D. Lungu	2023	2026
CoTL	Currently, the Committee on Teaching and Learning shall consist of a minimum of two Faculty members from each department, the Associate Dean – Students, one Librarian, one staff member, one undergraduate student, and two graduate students, in addition to other members invited as provided for by the Rules. Graduate students and staff nominees will indicate their interest in serving on the committee in writing to the committee, who will then approve by majority vote.	CoTL normally meets every third Thursday of each month (September to May) from 10:00 am - 11:30 am		
	Associate Dean - Students, Ex officio	M. Scheid	Designated	
	Assodiate Dean - Curriculum & Pedagogy	H. Kouyoumdjian	Designated	
	Graduate Student Representative	J. MacPherson	2023	2024
	Graduate Student Representative	Aysa Tajeri	2023	2024
	Undergraduate Student Representative	VACANT	2023	2024
	Stacie Science Library, Designated	M. Wang	Designated	
	IT Representative	V. Gotcheva	Designated	
	Teaching Commons Rep	Y. Su	Designated	
	Staff representative, Elected	D. Hossain	2023	2024
	Biology	T. Kelly	2023	2026
	Biology	J. Atallah	2023	2026
	Chemistry	T. Mirkovic	2023	2026
	Chemistry	T. Zeng	2022	2025
	Physics & Astronomy	N. Blinov	2023	2024
	Physics & Astronomy	C. Boukaré	2023	2024
	Math & Stats	J. Cao	2022	2025
	Math & Stats	A. McEachern	2023	2026
	Science, Technology & Society	R. Marushia	2022	2025
Committee on Research & Awards	The Committee on Research and Awards shall consist of one member elected by Council from each of Biology, Chemistry, Mathematics and Statistics, Science, Technology & Society/Natural Science, and Physics and Astronomy, one student member of Council and an Associate Dean (*ex officio*).	The Research & Awards Committee will meet when grants and awards need to be adjudicated.		
	Associate Dean - Research & Partnerships, ex officio	V. Saridakis	Designated	
	Undergraduate Student Representative	VACANT	2023	2024
	Graduate Student	Andrea Angelucci	2023	2024
	Biology	D. Golemi-Kotra	2023	2026
	Chemistry	S. Morin	2022	2025
	Physics & Astronomy	R. Kannan	2023	2024
	Math & Stats	H. Zhu	2023	2026
	Science, Technology & Society	H. Mialet	2023	2026
Appeals Committee	The Appeal Committee for the purpose of hearing student appeals shall consist of four elected faculty members from Science units, an Associate Dean (ex officio) and two student members of Council. A quorum shall consist of either (a) two faculty members and one student member or (b) three faculty members.	Meeting is held once a month and times are polled by the Committee Secretary.		
	Associate Dean - Faculty, ex officio	G. Audette	Designated	
	Undergraduate Student Representative	VACANT	2023	2024
	Undergraduate Student Representative	VACANT	2023	2024
	Member at Large	VACANT	2023	2026
	Biology	L. Donaldson	2023	2026
	Chemistry	M. Hempstead (Fall), L. Hébert (Winter)	2023	2026
	Physics & Astronomy	S. Tulin	2023	2024
	Math & Stats	M.W. Wong	2023	2026
	Science, Technology & Society	D. Monaldi	2023	2026

2023-2024 FSc Report on vacancies for Senate and FSc Standing Committees

Committee	Rules of Faculty Council - membership	Meeting time / Membership	Term	
			From	To
Graduate Curriculum Committee	To provide broad review and commendation to Council via the Academic Policy and Planning Committee of all proposals received from Graduate Programs with respect to: New Course Proposals , Course Change Proposals, Minor Changes to Program/Graduate Diploma Academic Requirements, Major Modifications to Program/Graduate Diploma Academic Requirements, New Graduate Fields, New Graduate Diplomas, New Graduate Degree Programs The Graduate Education Committee shall consist of: - Associate Dean – Research & Graduate Education (ex officio) - Graduate Program Director (or designate who must be a member of the graduate program) of each Graduate Program in the Faculty of Science -one graduate student member from any Graduate Program within the Faculty of Science -one full-time faculty member from the Faculty of Health or Lassonde School of Engineering who is appointed to teach in any FSc graduate program - A member at large with knowledge of graduate programming, and experience with curriculum approvals at the Faculty-level. The Chair of the Committee is selected by the voting members of the Committee for a one-year term.	Meeting is held based on availability.		
	Associate Dean – Associate Dean Students (ex officio)	M. Scheid	Designated	
	Biology	J. Paluzzi	2023	2026
	Chemistry	R. Hili	2023	2026
	Physics & Astronomy	A. Muzzin	2023	2026
	Math & Stats	P. Ingram	2023	2026
	Science, Technology & Society	VACANT	2023	2026
	Member from Faculty of Health OR Lassonde	VACANT	2023	2026
	Member at Large	D. Golemi-Kotra	2023	2026
	Graduate student	Farnaz Mansouri-Noori	2022	2024
Committee on Equity, Diversity & Inclusion	The purpose of the Committee on Equity, Diversity & Inclusivity is to provide broad review and leadership to Council on matters of Equity, Diversity and Inclusivity issues with respect to: • Tenure and Promotions • Hiring and Retention of members form EDI groups • Approaches to addressing gender bias in the workplace • Research engaging equity recognized groups • Workload and service contributions of EDI members • EDI experiences in Teaching and Learning The Equity, Diversity and Inclusivity committee shall consist of: • Associate Dean, Faculty Affairs (ex officio) • Associate Dean,Research and Partnerships (ex officio) • One primary and one alternate member from each of Biology, Chemistry, Mathematics & Statistics, Physics & Astronomy and Science, Technology & Society. • Two graduate students or postdoctoral fellow/visitors (one primary and one alternate) from any graduate program within the Faculty of Science • One undergraduate student	Meeting is held the last Wednesday of every month.		
	Associate Dean - Faculty, ex officio	G. Audette	Designated	
	Associate Dean, Research & Partnerships (ex officio)	V. Saridakis	Designated	
	Undergraduate Student Representative	VACANT	2023	2024
	Graduate Student	Aishwarya Subramanian	2023	2024
	Graduate Student	Thomas Vacheresse	2023	2024
	Biology	T. Kelly	2021	2024
	Chemistry	C. Young	2023	2026
	Physics & Astronomy	P. Scholz	2023	2026
	Math & Stats	A. Woldegerima ALT A. Lumley	2022	2025
	Science, Technology & Society	V. Pavri	2023	2024

CURRICULUM COMMITTEE REPORT

October 2023

The Faculty of Science Curriculum Committee has reviewed proposals for changes to course information and degree requirements and recommends to the Executive Committee that the following changes be submitted to Council for approval.

Details regarding these proposals (and other minor changes to Calendar/Repository course descriptions and prerequisites which were approved by the Committee but are not reported here) are included in the working papers of April 25, 2023, May 30, 2023, June 27, 2023, August 1, 2023 and September 26, 2023, meeting of the of the Curriculum Committee, which are on file for your inspection in the Office of the Dean, with all members of the Curriculum Committee or by contacting the Secretary of the Committee at scicurri@yorku.ca

April 2023 Curriculum Meeting

1) BIOLOGY
a) Change in prerequisites: SC/BIOL 3002 – Field Course (cross-listed to SC/ENVB 3002 3.0)
b) Change in prerequisite and course number: SC/BIOL 3003 3.0, Field Course (cross-listed to SC/ENVB 3003 3.0)
- Please Note: Associate Dean Scheid noted typo on page 8 (i.e. SC/BIOL 4001 3.00 and SC/BIOL 3002 3.0) and that SC/BIOL 3002 3.0 should be SC/BIOL 4002 3.0.

(**submitted by Prof. Nicole Nivillac**)

May 2023 Curriculum Meeting

1) BIOLOGY
a) New Course proposal: SC/BIOL 4070 3.0 (cross-listed to SC/ENVB 4070 3.0)
(**submitted by Prof. Nicole Nivillac**)

2) CHEMISTRY
a) New Course proposal: SC/CHEM 4055 3.0 (cross-listed to SC/BCHM 4055 3.0)
(**submitted by Prof. Derek Jackson and Kyle Belozerov)**

3) MATHEMATICS & STATISTICS
a) Change to existing course: SC/MATH 3901 0.0 (Change in prerequisites)

b) Change to existing course: SC/MATH 3902 0.0 (Change in prerequisites)
c) Change to existing course: SC/MATH 3903 0.0 (Change in prerequisites)
d) Change to existing course: SC/MATH 3904 0.0 (Change in prerequisites)
(**submitted by Prof. E. J. van Rensburg)**

3) PHYSICS & ASTRONOMY
a) Change to existing course: SC/PHYS 3070 3.0 (Change in prerequisites)
(**submitted by Matthew George)**

June 2023 Curriculum Meeting

1) BIOLOGY
a) New Course proposal: SC/BIOL 3095 3.0
(**submitted by Prof. Mark Vicari**)

2) BIOPHYSICS
a) Non-Major Modification: Change to program core in Biophysics Specialized Honours Program
(**submitted by Prof. Matthew George)**

3) MATHEMATICS & STATISTICS
a) Change to Existing Course: SC/MATH 1019 3.0 (Change in prerequisites)
Note: Cross-listed to LE/EECS 1019 3.0 - copy of proposal has been provided to Lassonde for curricular review.
b) Change to Existing Course: SC/MATH 1021 3.0 (Change in prerequisites)
c) Change to Existing Course: SC/MATH 1090 3.0 (Change in prerequisites)
d) Change to Existing Course: SC/MATH 1190 3.0 (Change in prerequisites)
e) Change to Existing Course: SC/MATH 1300 3.0 (Change in prerequisites)
f) Change to Existing Course: SC/MATH 1310 3.0 (Change in prerequisites)
g) Change to Existing Course: SC/MATH 2001 3.0 (Change in prerequisites)
h) Change to Existing Course: SC/MATH 2022 3.0 (Change in prerequisites)
i) Change to Existing Course: SC/MATH 2310 3.0 (Change in prerequisites)
j) Change to Existing Course: SC/MATH 3001 3.0 (Change in prerequisites)
k) Change to Existing Course: SC/MATH 3010 3.0 (Change in prerequisites)
l) Change to Existing Course: SC/MATH 3021 3.0 (Change in prerequisites)
m) Change to Existing Course: SC/MATH 3021 3.0 (Change in title)
n) Change to Existing Course: SC/MATH 3022 3.0 (Change in prerequisites)
o) Change to Existing Course: SC/MATH 3022 3.0 (Change in title)
p) Change to Existing Course: SC/MATH 3410 3.0 (Change in prerequisites)
q) Change to Existing Course: SC/MATH 4011 3.0 (Change in prerequisites)
r) Change to Existing Course: SC/MATH 4011 3.0 (Change in title)

s) Change to Existing Course: SC/MATH 4012 3.0 (Change in prerequisites)

t) Change to Existing Course: SC/MATH 4012 3.0 (Change in title)

u) Change to Existing Course: SC/MATH 4021 3.0 (Change in prerequisites)

v) Change to Existing Course: SC/MATH 4021 3.0 (Change in title)

w) Change to Existing Course: SC/MATH 4022 3.0 (Change in prerequisites)

x) Change to Existing Course: SC/MATH 4081 3.0 (Change in prerequisites)

y) Change to Existing Course: SC/MATH 4160 3.0 (Change in prerequisites)

(**submitted by Prof. E. J. van Rensburg)**

4) NATURAL SCIENCE

a) Change to Existing course: SC/NATS 1515 3.0 (Change in prerequisites)

b) Change to Existing course: SC/NATS 1665 3.0 (Change in prerequisites)

c) Change to Existing course: SC/NATS 1870 6.0 (Change in format/mode of delivery)

d) Change to Existing course: SC/NATS 1920 6.0 (Change in title and course description) Note: Friendly amendment to title “Great Mathematical Minds”

(**submitted by Prof. R. Metcalfe)**

5) PHYSICS & ASTRONOMY

a) Change to Existing course: SC/PHYS 1800 3.0 (Change to format/mode of delivery)

b) New Course Proposal: SC/PHYS 3130 3.0

c) Change to Existing course: SC/PHYS 4020 3.0 (Change to prerequisites)

(**submitted by Prof. M. George)**

August 2023 Curriculum Meeting

1) NATURAL SCIENCE

a) Change to Existing Course: SC/NATS 1920 6.0 (Change to title and course description)

Note: Proposal updated to reflect change friendly amendment from previous meeting.

b) Change to Existing Course: SC/NATS 1880 6.0 (Change to course exclusions and NCR note)

c) New Course Proposal: SC/NATS 1572 3.0

d) New Course Proposal: SC/NATS 1506 3.0

(**submitted by Prof. R. Metcalfe)**

September 2023 Curriculum Meeting

1) BETHUNE

a) Change to Existing Course: SC/BC 3010 3.0 (Change in Mode of Delivery)

Note: ONLN tabled, ONCA & LECT approved.

(**submitted by Prof. P. Wilson)**

2) GEOGRAPHY

a) Change to Exisiting Course: SC/GEOG1402 3.00 (Change to Cross-listing)
b) Change to Exisiting Course: SC/GEOG 2340 3.00 (Change to Cross-listing)
c) Change to Exisiting Course: SC/GEOG2420 3.00 (Change to Cross-listing)
d) Change to Exisiting Course: SC/GEOG2420 3.00 (Change to Cross-listing)
e) Change to Exisiting Course: SC/GEOG2500 3.00 (Change to Cross-listing)
f) Change to Exisiting Course: SC/GEOG2600 3.00 (Change to Cross-listing)
g) Change to Exisiting Course: SC/GEOG2610 3.00 (Change to Cross-listing)
h) Change to Exisiting Course: SC/GEOG3100 3.00 (Change to Cross-listing)
i) Change to Exisiting Course: SC/GEOG3200 3.00 (Change to Cross-listing)
j) Change to Exisiting Course: SC/GEOG3340 3.00 (Change to Cross-listing)
k) Change to Exisiting Course: SC/GEOG3360 3.00 (Change to Cross-listing)
l) Change to Exisiting Course: SC/GEOG3440 3.00 (Change to Cross-listing)
m) Change to Exisiting Course: SC/BIOL3500 3.00, SC/GEOG 3500 3.00 (Change to Cross-listing)
n) Change to Exisiting Course: SC/GEOG 3510 3.00 (Change to Cross-listing)
o) Change to Exisiting Course: SC/GEOG 3540 3.00 (Change to Cross-listing)
p) Change to Exisiting Course - SC/GEOG 3700 3.00 (Change to Cross-listing)
q) Change to Exisiting Course - SC/GEOG 3900 3.00 (Change to Cross-listing)
r) Change to Exisiting Course - SC/GEOG 4000 3.00 (Change to Cross-listing)
s) Change to Exisiting Course - SC/GEOG4180 3.00 (Change to Cross-listing)
t) Change to Exisiting Course - SC/GEOG 4200 3.00 (Change to Cross-listing)
u) Change to Exisiting Course - SC/GEOG 4205 3.00 (Change to Cross-listing)
v) Change to Exisiting Course - SC/GEOG 4210 3.00 (Change to Cross-listing)
w) Change to Exisiting Course - SC/GEOG 4215 3.00 (Change to Cross-listing)
x) Change to Exisiting Course - SC/GEOG 4290 6.00 (Change to Cross-listing)
y) Change to Exisiting Course - SC/GEOG 4290 3.00 (Change to Cross-listing)
z) Change to Exisiting Course - SC/GEOG 4310 3.00 (Change to Cross-listing)
aa) Change to Exisiting Course - SC/GEOG 4340 3.00 (Change to Cross-listing)
bb) Change to Exisiting Course - SC/GEOG 4400 3.00 (Change to Cross-listing)
cc) Change to Exisiting Course - SC/GEOG 4440 3.00 (Change to Cross-listing)
dd) Change to Exisiting Course - SC/GEOG 4541 3.00 (Change to Cross-listing)
ee) Change to Exisiting Course - SC/GEOG 4600 3.00 (Change to Cross-listing)

(**submitted by Sharrieff Sattaur)**

3) NATURAL SCIENCE

a) Change to Existing Course - SC/NATS 1512 3.0 (Change to Mode of Delivery)

Note: ONLN tabled, ONCA & LECT approved.

b) Change to Existing Course - SC/NATS 1765 6.0 (Change to Mode of Delivery)

Note: ONLN tabled, ONCA & LECT approved.

(**submitted by Prof. R. Metcalfe)**

Changes to Existing Course

Faculty:

Department:	Biology	**Date of Submission:**	February 2023
Course Number:	SC/BIOL 3002 3.0/SC/ENVB 3002 3.0	**Effective Session:**	Sept. 2024
Course Title:	Field Course		

Type of Change:

X	in pre-requisite(s)/co-requisite(s)		in cross-listing
X	in course number/level		in degree credit exclusion(s)
	in credit value		regularize course (from Special Topics)
	in title (max. 40 characters for short title)		in course format/mode of delivery *
	in Calendar description (max. 40 words or 200 characters)		retire/expire course
	other (please specify):		

Change From:	**To:**
SC/BIOL ~~3002 3.00~~ Field Course This is a second field course, which may be taken for credit, the contents of which must differ materially from ~~SC/BIOL 3001 2.00 or SC/BIOL 3001 3.00~~ as determined by the Instructor. The departmental brochure should be consulted for further details. Two-week field course. Prerequisites: SC/BIOL 2050 4.00 and SC/BIOL 2060 3.00; plus other prerequisites if specified for a given module. Note: Students must be manually enrolled in this course through the Biology Department early in January or prior to the session in which the course is offered. Enrolment is not possible at any other time of year. In addition to the tuition fee levied by the University, each student must pay for transportation, room and board.	SC/BIOL 4002 3.00 Field Course This is a second field course, which may be taken for credit, the contents of which must differ materially from SC/BIOL 4001 3.00 as determined by the Instructor. The departmental brochure should be consulted for further details. Two-week field course. Prerequisites: SC/BIOL 2050 (3.00 or 4.00) and SC/BIOL 2060 3.00; plus other prerequisites if specified for a given module. Recommended: SC/BIOL 2080 3.00 Cross-listed: SC/ENVB 4002 3.00 Note: Students must be manually enrolled in this course through the Biology Department in early January or prior to the session in which the course is offered. Enrolment is not possible at any other time of year. In addition to the tuition fee levied by the University, each student must pay for transportation, room and board.

Rationale:

Course code change: SC/BIOL 3001 was successfully changed to SC/BIOL 4001 in 2021 and this change will ensure all field courses are offered at the 4000 level. This change also provides a much wider selection of course options since many other OUPFB field courses are listed under 4th year codes.

Removal of SC/BIOL 3001 2.0: This version of the field course has been retired so should be removed from the calendar copy.

Pre-requistie changes: These changes will allow for inclusion of the new SC/BIOL 2050 3.0 credit course (alongside the original SC/BIOL 2050 4.0) and a recommendation for students to take the SC/BIOL 2080 3.0 Laboratory-based course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Biology	**Date of Submission:**	February 2023
Course Number:	SC/BIOL 3003 3.0/SC/ENVB 3003 3.0	**Effective Session:**	Sept. 2024
Course Title:	Field Course		

Type of Change:

X	in pre-requisite(s)/co-requisite(s)		in cross-listing
X	in course number/level		in degree credit exclusion(s)
	in credit value		regularize course (from Special Topics)
	in title (max. 40 characters for short title)		in course format/mode of delivery *
	in Calendar description (max. 40 words or 200 characters)		retire/expire course
	other (please specify):		

Change From:	**To:**
SC/BIOL ~~3002 3.00~~ Field Course This is a third field course, which may be taken for credit, the contents of which must differ materially from ~~SC/BIOL 3001 2.00 or SC/BIOL 3001 3.00, and SC/BIOL 3002 2.00 or SC/BIOL 3002 3.00~~, as determined by the Instructor. The departmental brochure should be consulted for further details. Two-week field course. Prerequisites: SC/BIOL 2050 4.00 and SC/BIOL 2060 3.00; plus other prerequisites if specified for a given module. Note: Students must be manually enrolled in this course through the Biology Department early in January or prior to the session in which the course is offered. Enrolment is not possible at any other time of year. In addition to the tuition fee levied by the University, each student must pay for transportation, room and board. This is a third field course, which may be taken for credit, the contents of which must differ materially from SC/BIOL 3001 2.00 or SC/BIOL 3001 3.00, and SC/BIOL 3002 2.00 or SC/BIOL 3002 3.00, as determined by the Instructor. The departmental brochure should be consulted for further details. Two-week field course. Prerequisites: SC/BIOL 2050 4.00 and SC/BIOL 2060 3.00; plus other prerequisites if specified for a given module. Note: Students must be manually enrolled in this course through the Biology Department early in January or prior to the session in which the course is offered. Enrolment is not possible at any other time of year. In addition to the tuition fee levied by the University, each student must pay for transportation, room and board.	SC/BIOL 4002 3.00 Field Course This is a third field course, which may be taken for credit, the contents of which must differ materially from SC/BIOL 4001 3.00 and SC/BIOL 3002 3.0 as determined by the Instructor. The departmental brochure should be consulted for further details. Two-week field course. Prerequisites: SC/BIOL 2050 (3.00 or 4.00) and SC/BIOL 2060 3.00; plus other prerequisites if specified for a given module. Recommended: SC/BIOL 2080 3.00 Cross-listed: SC/ENVB 4002 3.00 Note: Students must be manually enrolled in this course through the Biology Department in early January or prior to the session in which the course is offered. Enrolment is not possible at any other time of year. In addition to the tuition fee levied by the University, each student must pay for transportation, room and board.

Rationale:

Course code change: SC/BIOL 3001 was successfully changed to SC/BIOL 4001 in 2021 and this change will ensure all field courses are offered at the 4000 level. This change also provides a much wider selection of course options since many other OUPFB field courses are listed under 4th year codes.

Removal of SC/BIOL 3001 2.0 and SC/BIOL 3001 3.0: These version of the field course has been retired so should be removed from the calendar copy.

Pre-requistie changes: These changes will allow for inclusion of the new SC/BIOL 2050 3.0 credit course (alongside the original SC/BIOL 2050 4.0) and a recommendation for students to take the SC/BIOL 2080 3.0 Laboratory-based course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

September 2, 2020

Biol4070 – Behavioural Ecology

Required and Recommended Reading List:

I have reviewed the bibliography that you provided with the course description. We have subscriptions to all the recommended journals for the course, and a recommended reading list book has been placed on order.

Electronic Resources and Databases:

The primary databases and indexes of relevance include Biological Abstracts (Clarivate), Web of Science (Clarivate), Scopus (Elsevier), PsycINFO (Ovid and ProQuest), Medline (Ovid), Embase (Ovid), and Ulrich's International Periodicals Directory, in addition to other specialized electronic resources.
Numerous electronic books and other resources in Ecology, Biology, and Psychology, and other relevant subject areas are also available in the York Libraries catalogue.

Style guides:

Council of Science Editors. Style Manual Committee. (2014). *Scientific style and format: The CSE manual for authors, editors, and publishers* (Eighth edition.). Council of Science Editors.

American Psychological Association. (2020). Publication manual of the American Psychological Association (7th ed.). Washington, DC: American Psychological Association.

Iverson, C., & American Medical Association. (2007). AMA manual of style: A guide for authors and editors (10th ed. / Cheryl Iverson (chair) ... [et al.].). Oxford; New York: Oxford University Press.

The holdings in our library currently support undergraduate and graduate-level courses in related Ecology, Biology, Psychology, and Neuroscience courses. Should there be a need for articles not available in our holdings, interlibrary loan and document delivery options are available through RACER for any additional information needs that may come up. There is no limit to the number of articles that a student or faculty member may order through RACER per year, and these are delivered to the desktop, free of charge. Books can also be requested through both the OMNI and the RACER systems free of charge. Registration and requesting is available from:
http://www.library.yorku.ca/cms/resourcesharing/services-for-york-faculty-and-students/illrequestform/ .

Should course instructors want to place any required readings on reserve for student use at Steacie Library, please see the following http://www.library.yorku.ca/cms/faculty/reserves/ for information about what materials can be posted, Fair Dealing Guidelines, etc. Items to be posted can be requested by filling out the form at: http://www.library.yorku.ca/cms/faculty/reserve-request-steacie/ .
Permanent links to articles we subscribe to can be created for posting in course management systems, and instructions are available here: https://researchguides.library.yorku.ca/permalinks

Library Research and Information Literacy Support:

Librarians provide research skills workshops to students and faculty on request, including but not limited to:

- Designing research strategies from asking a research question to searching the library catalogue, government sources, and databases.
- Using CSE or another citation style.

- Classes are provided on managing references using Zotero bibliographic management software. Registration is through this link: https://yorku.libcal.com/calendar/libraryworkshops?cid=7880&t=d&d=0000-00-00&cal=7880&inc=0

Research guides:

An Ecology Research Guide, Biology Research Guide, Psychology Research Guide, Neuroscience Research Guide, and Research Guides in related fields have been created and are maintained by subject librarians to bring together online and print resources that may be useful to students and faculty in Ecology. Resources and links will be added upon request.

https://researchguides.library.yorku.ca/Ecology
http://researchguides.library.yorku.ca/Biology
https://researchguides.library.yorku.ca/Psychology
https://researchguides.library.yorku.ca/Neuroscience

Collection development in the library is ongoing and is based on a commitment to developing library resources that are in alignment with the University's curricular and research activities. Books in this field will be added to the library collection as they are published. Please forward any requests for purchase to the Biology Subject Librarian: ilo@yorku.ca or submit your purchase request by using the form at https://www.library.yorku.ca/web/collections/suggestion-for-purchase-form/

In summary, I would state that we are well positioned to support this course.

Sincerely,

Ilo-Katryn Maimets, Science Librarian
102K Steacie Science and Engineering Library
E-mail: ilo@yorku.ca

COMMITTEE ON ACADEMIC STANDARDS, CURRICULUM AND PEDAGOGY TEMPLATE

NEW COURSE PROPOSAL FORM

Faculty: Indicate all relevant Faculty(ies)	Science

Department: Indicate department and course prefix (e.g. Languages, GER)	Biology (BIOL/ENVB)	**Date of Submission:**	March 3rd, 2023

Course Number: Special Topics courses Include variance (e.g. HUMA 3000C 6.0, Variance is "C")	BIOL 4070 3.00, cross-listed to ENVB 4070 3.00	**Var:**	**Academic Credit Weight:** Indicate both the fee, and MTCU weight if different from academic weight (e.g. AC=6, FEE=8, MET=6	3.00

Course Title: The official name of the course as it will appear in the Undergraduate Calendar and on the Repository	Behavioural Ecology
Short Title: Appears on any documents where space is limited - e.g. transcripts and lecture schedules - **maximum 40 characters**	Behavioural Ecology

With every new course proposal, it is the Department's responsibility to ensure that new courses do not overlap with existing courses in other units. If similarities exist, consultation with the respective departments is necessary to determine degree credit exclusions and/or cross-listed courses.

Brief Course Description:

Maximum 2000 characters
(approximately 300 words including spaces and punctuation).

The course description should be carefully written to convey what the course is about. It should be followed by a statement of prerequisites and co-requisites, if applicable. This description appears in the calendar.

For editorial consistency, and in consideration of the various uses of the Calendars, verbs should be in the present tense (i.e., "This course analyzes the nature and extent of...," rather than "This course will analyze...")

Behavioural ecology focuses on the behavioural interactions among individuals at both the intraspecific level in natural populations and the interspecific level in natural communities. Behavioural ecology asks questions about proximate and ultimate causes of behaviour, the development of behaviour, the flexibility of behaviour and learning, the adaptive value of behaviour for survival and reproduction, and the phylogenetic relationships among diverse behavioural patterns. In an overarching sense, it considers behavioural interactions against the metric of evolutionary fitness. A common focus of behavioural ecologists' research is to consider how efficiently animals use their time and energy in obtaining mates and resources against measures of survival and reproductive success, including analyses of the trade-offs associated with optimizing the use of time and energy.

This course explores the many behavioural contexts that are manifest in natural populations of animals. Major themes include (a) behaviours under competition, including evolutionary stable strategies, frequency dependence, and the application of game theory; (b) behavioural plasticity; (c) changing behaviours in environments of changing or complex selective pressures; (d) territorial behaviour and economic defendability; (e) sex-specific patterns of behaviour in the mating realm, including the operation of sexual selection, the phylogeny of mating systems, the mediation of challenges based in sexual conflict, and behaviourally flexible alternative mating strategies; (f) patterns of behaviour related to parenting, including mother-father conflict, parent-offspring conflict, and sibling conflict; (g) both antagonistic and cooperative social behaviours, including alloparenting and the special case of social insects; and (h) communication and signaling behaviours in diverse sensory realms. This course is lecture-based, supplemented by related readings.

Pre-requisites: SC/BIOL/ENVB 3.00 2050 *Ecology* and SC/BIOL 2060 3.00 *Statistics for Biologists*.

Course Credit Exclusion:

HH/PSYC 3280 3.00 *Animal Behaviour*

Generic Course Description:

This is the description of the "Parent / Generic course" for Special Topics courses under which variances of the "Generic" course can be offered in different years (Max. 40 words). Generic course descriptions are published in the calendar.

List all degree credit exclusions, prerequisites, integrated courses, and notes below the course description.

This is a lecture-based course that focuses on the behavioural interactions among individuals at both the intraspecific level in natural populations and the interspecific level in natural communities. It considers behavioural interactions against the metric of evolutionary fitness.

Pre-requisites: SC/BIOL/ENVB 3.00 2050 *Ecology* and SC/BIOL 2060 3.00 *Statistics for Biologists*.

Course Credit Exclusion: HH/PSYC 3280 3.00 *Animal Behaviour*

Expanded Course Description:

Please provide a detailed course description, including topics / theories and learning objectives, as it will appear in supplemental calendars.

A. Course Outcomes and Learning Objectives

By the end of this course, students will be able to:

Area 1. Fundamental Understanding:

- Use terminology appropriate to the field of behavioural ecology
- Recognize key conceptual ideas central to behavioural ecology, such as evolutionary stable strategy
- Using fundamental principles from evolutionary biology, demonstrate an understanding of selective environments and adaptive behaviours
- Using fundamental principles from life history biology, demonstrate an understanding of behavioural trade-offs in terms of time, resources, and energy
- Develop models for applying game theory and the calculus of economic defendability to behavioural contexts
- Apply the principles of hypothesis testing to behavioural ecology situations
- Compare the operations of evolutionary arms races in different behavioural contexts, such as predatory, parasitic, and competitive relations
- Contrast behavioural attributes of species that are mostly solitary versus those that are social, and identify the benefits or each and the ecological constraints generating each
- Differentiate among theories of sexual selection, and the contributions each makes to the reality of sexual conflict and to the evolution of different mating systems
- Distinguish among different patterns of parental care, including group parenting, dual parenting, single parenting, and alloparenting
- Identify and contrast different types of relationships in intra-family conflict, including mother-father, parent-offspring, and sibling conflict
- Present arguments for circumstances that lead to cooperative behaviours either among kin or among non-kin
- Compare and contrast the utility of different sensory realms in communication and signaling behaviour
- Apply the principles of behavioural ecology to issues of conservation
- Apply behavioural ecology principles to wildlife management challenges
- Use natural history knowledge

Area 2. Critical Thinking Skills

- Employ case studies as exemplars of behavioural ecology concepts
- Draw generalized concepts from the results of particular scientific studies or experiments (inductive reasoning)
- Present arguments that explain evolutionary phenomena such as evolutionary stable strategies and alternative mating strategies
- Apply course content to new data sets
- Employ metaphors for conveying the principles of behavioural ecology
- Assess the effectiveness of experimental designs in answering questions about behaviours in natural settings

Area 3. Problem Solving Skills

- Accept a position regarding a contentious theory in behavioural ecology and formulate the argument in favour of that position
- Apply principles from the scientific literature to new fact situations
- Consider diverse field or lab methods for collecting data and apply appropriate methodologies to particular questions related to behavioural ecology

Area 4. Effective Communication

- On tests and exams, clearly construct written answers to questions and clearly construct written explanations or arguments for scenarios or fact situations
- In written submissions, effectively summarize information and draw conclusions based on that presentation of information
- In lectures, ask and answer questions, make relevant observations, and effectively defend a position regarding a principle of behavioural ecology, including referencing material from a reading list in support

Area 5. Analytical Skills

- Analyze data generated in behavioural ecology research in order to assess the validity of working hypotheses in the field of behavioural ecology
- Analyze datasets to assess whether they support specific hypotheses in behavioural ecology, such as natural, sexual selection, or kin selection of particular phenotypic attributes, or of co-evolved behaviours
- Apply statistics to behavioural ecology datasets

B. Selected Topics

The following suggests how the course can be structured over a single term. In each week, case studies or commentary articles that are useful in the analysis of behavioural ecology concepts or controversies will be required reading, in order to exemplify theoretical analyses.

Week #1 - Review of fundamentals and introduction
Introductory material begins with a review of key concepts from second-year Ecology that are key to the sub-discipline of Behavioural Ecology, and unfamiliar key concepts emanating from them, including adaptation, coevolution, community relationships, conditional strategy, cost-benefit models, demography, evolutionary stable strategy, fitness, life history trade-offs, and sexual selection. Week 1 also includes a primer on deep observation approaches used in natural history that supplement experimental behavioural ecology.

Week #2 – Natural selection, ecology, and behaviour
This material will focus on questions that arise from observed behaviours and the framework used to answering such questions. This framework combines thinking about behaviour, natural environments (as the stage on which behaviours are manifest), and the mechanisms of evolution. This will begin with Tinbergen's 4 questions related to causation, development, adaptation, and phylogeny.

Week #3 – Economic decision-making and optimality theory
This material begins by considering the three methods of hypothesis testing in behavioural ecology: comparison among individuals within a species, comparison among species, and experimentation. This will then move to the utility of using economic analysis of costs and benefits as a tool for considering optimality models.

Week #4 – Evolutionary arms races, resource contexts, and evolutionary stable strategies
This material is primarily co-evolutionary, as it focuses on gene pool changes that are driven by interspecific interactions, that lead to co-evolved phenotypic expressions of behaviour. These include behavioural responses and counter-responses in predator-prey relations, interspecific competition, host-parasite relations, and mutualistic relations. Game theory is introduced as a tool, and the concept of evolutionary stable strategies is developed.

Week #5 – Sexual selection
The brief sexual selection foundation from first year Biology will be built upon. Sexual dimorphism often includes behavioural differences, and these will be characterized and compared among species. Major theories of sexual selection (good genes, runaway, sensory bias) will be considered in the context of behaviour. Major attributes of sexually selected systems, including different measures of variance in sexual success and different levels of investment between males and females will be demonstrated using case studies.

Week #6 – Sexual Conflict
The development of sexual conflict as a growing subdiscipline of ethology is considered. Comparative and experimental work that demonstrates behavioural patterns that reflect different male and female optima in reproductive instincts and decision-making are analyzed.
Sperm competition, with its associated behavioural patterns before mating, during mating, and after mating, is an area of particular focus.

Week #7 – Parental care and family conflict
Conflicts that arise between individuals in the mating realm can continue or morph during the period in which there is parental care, and this material focuses on these different behavioural manifestations of inter-individual conflict. Three major areas are considered: continuing conflict between mother and father, conflict between parent and offspring, and conflict between siblings.

Week #8 – Mating systems
The outcomes of sexual and family conflicts that operate in the immediate term produce mating systems in the longer term. Mating systems constitute patterns of behaviour that determine how mates are acquired, how many mates an individual may have, and associated patterns of parental care that result from individuals optimizing time, energy, and resources in the mating realm. Case studies of monogamy with biparental care, polygamy, and promiscuity are considered, as are the theories that produce these systems. Sex allocation theory and evidence are also considered.

Week #9 – Communication and signaling
Many behaviours involve communication, some of which employ special rules and modes of signaling, as well as meaningful displays. Communication is studied from the dual perspectives of sender and receiver, and reviews case studies where different sensory modalities are primary. The evolutionary stability of signals is considered, and consideration is given to the amount of manipulation or dishonesty communication systems can contain and still be of net benefit to both sender and receiver.

Week #10 – Group living
There are costs associated with group living, yet many species collect in groups; this week group living is investigated by looking at the costs and benefits of group living, with special attention to two areas where there has been long-term development of theory and hypothesis-testing: predation reduction and foraging success. Optimal group size, skew theory, and leadership will be considered.

Week #11 – Social behaviour
This material starts from the foundational idea that natural selection primarily acts at the individual level, leading to directly or indirectly self-interested behaviours. Clearly, individuals exhibit behaviours that are, or appear, cooperative or even altruistic. Within the area of cooperation, free-riding, hidden benefits, reciprocity, manipulation, and enforcement are considered. Within the area of apparent altruism, patterns of behaviour are investigated through the models of kin selection, inclusive fitness, and eusociality.

Week #12 – Applied behavioural ecology
Many species and communities have been dramatically affected by anthropogenic changes and the application of behavioural ecology to this challenge is the concluding subject of the course. Case studies are used where the behaviour of individuals is manipulated in pursuit of wildlife management goals.

Course Design:

Indicate how the course design supports students in achieving the learning objectives. For example, in the absence of scheduled contact hours what role does student-to-student and/or student-to-instructor communication play, and how is it encouraged?

Detail any aspects of the content, delivery, or learning goals that involve "face-to-face" communication, non-campus attendance or experiential education components.

Alternatively, explain how the course design encourages student engagement and supports student learning in the absence of substantial on-campus attendance.

The course supports the achievement of learning objectives by means of face-to-face communication with the Course Director during lecture hours and drop-in office hours. Lectures may be designed on, or partly on, a flipped classroom model. The use of case studies in lecture material, as well as supplemental readings provided on a course website, will supplement the theoretical and other in-lecture material.

Instruction:

1. Planned frequency of offering and number of sections anticipated (every year, alternate years, etc.).
2. Number of department members currently competent to teach the course.
3. Instructor(s) likely to teach the course in the coming year.
4. An indication of the number of contact hours (defined in terms of hours, weeks, etc.) involved, in order to indicate whether an effective length of term is being maintained **OR** in the absence of scheduled contact hours a detailed breakdown of the estimated time students are likely to spend engaged in learning activities required by the course.

1. This 3-credit, 12-week course should be offered once a year, preferably in the fall or winter term; BIOL/ENVB 3171, BIOL/ENVB 3172, and this course should not all be offered in the same term.

2. This course could be taught by at least three faculty members, including Alex Mills, Beth Clare, Mark Vicari, Chris Lortie, and Tamara Kelly

3. Professor Alex Mills was scheduled to teach this course in Winter 2024; however it could not be mounted because a fresh proposal was required. Alex Mills is the author of this proposal. Accordingly, Alex Mills is the professor most likely to teach it if it is offered in FW24.

4. Three lecture hours per week, as well as at least one office hour per week for the Course Director.

5. On average, students will be required to do about three hours of preparation per week for each class.

Evaluation:

A detailed percentage breakdown of the basis of evaluation in the proposed course must be provided.

If the course is to be integrated, the additional requirements for graduate students are to be listed.

If the course is amenable to technologically mediated forms of delivery please identify how the integrity of learning evaluation will be maintained. (e.g. will "on-site" examinations be required, etc.)

Mark Breakdown

- Six eClass quizzes (drop one) 10%
- Experimental Design – Journal paper Introduction 15%
- Experimental Design – Journal paper Methodology 10%
- In-class AV presentation 10%
- Midterm test (written answer) 25%
- Final exam (written answer) 30%

The eClass quizzes will be based on pre-lecture readings to assist students in their obligation to keep up with material as the semester progresses, and for them to check comprehension. They will be evenly dispersed through the semester, avoiding the Midterm test.

The Course Director will be available through office hours to assist students with course material and with the Experimental Design project (two components).

The AV presentation is a low stakes opportunity for students to practice and hone their public presentation skills.

The Midterm Test and the Final Exam are supervised tests. These written assessments are composed of questions requiring short written answers in some cases, and longer written answers in others. They may include some multiple choice questions that cover some of the content, but they will be primarily written answer assessments. Together, the questions thoroughly assess all the course material, and assess mainly the student's depth and breadth of knowledge of the course topics, including the assessment of outcomes set out in Areas 1 through 4 in the Course Outcomes and Learning Objectives, above. Demonstration of comprehension, analysis, and application of concepts is also required for the longer-answer questions.

Bibliography:

A READING LIST MUST BE INCLUDED FOR ALL NEW COURSES

The Library has requested that the reading list contain complete bibliographical information, such as full name of author, title, year of publication, etc., and that you distinguish between required and suggested readings. A statement is required from the bibliographer responsible for the discipline to indicate whether resources are adequate to support the course.

Also please list any online resources.

If the course is to be integrated (graduate/ undergraduate), a list of the additional readings to be required of graduate students must be included. If no additional readings are to be required, a rationale should be supplied.

LIBRARY SUPPORT STATEMENT MUST BE INCLUDED.

There are numerous comprehensive textbooks with *Animal Behaviour* in the title, and more particularly, there is a classic text dedicated to behavioural ecology currently in its 4th edition: An Introduction to Behavioural Ecology (Davies et al.), so should the Course Director choose to include a course text, there are options. At the time of writing, an adequate open-access book does not appear available, but it is likely that as time proceeds, one will be published, given the rate of expansion of open access sources. While some Course Directors might use a required text, others might treat a text as recommended and place several copies on Library Reserve. Here are three examples of potential texts:

- *An Introduction to Behavioural Ecology* (4th), 2012. NB Davies, JR Krebs, and SA West. Wiley-Blackwell. (most recommended)
- *An Introduction to Animal Behaviour* (6th), 2012. A Manning and M Stamp Dawkins. Cambridge University Press.
- *Animal Behaviour: An Evolutionary Perspective*, 2021. P Kappeler. Springer.

The Course Director will provide readings mounted on the course website. With sufficient investment of time and consideration, these could collectively replace a course text. These would include examples from the primary literature such as the journals *Behavioral Ecology* (Oxford University Press), *Behavioral Ecology and Sociobiology* (Springer) and *Behavioral and Evolutionary Ecology* (Frontiers).

The readings posted on the course website could also include thoughtful and fact-checked examples from the secondary literature, such as *Discover* magazine (e.g. "*Why cannibalism is common for some animals"*, May 3rd, 2022) or *Scientific American* (e.g. *"Right whales seem to think before they speak"*, April 9th, 2018).

Other Resources: A statement regarding the adequacy of physical resources (equipment, space, etc.) must be appended. If other resources will be required to mount this course, please explain **COURSES WILL NOT BE APPROVED UNLESS IT IS CLEAR THAT ADEQUATE RESOURCES ARE AVAILABLE TO SUPPORT IT.**	This course does not require resources outside of classroom space. So, there is no burden on lab facilities.

Course Rationale:

The following points should be addressed in the rationale:

How the course contributes to the learning objectives of the program / degree.

The relationship of the proposed course to other existing offerings, particularly in terms of overlap in objectives and/or content. If inter-Faculty overlap exists, some indication of consultation with the Faculty affected should be given.

The expected enrolment in the course.

There is a two-part rationale for proposing this *Behavioural Ecology* course.

The first is that this document is resurrecting a course that previously existed. The Department of Biology retired BIOL 4070 3.0 *Behavioural Ecology* s about ten years ago and replaced it with a Sociobiology course that has never been mounted. Behavioural Ecology includes Sociobiology, and this proposal reincarnates the original course, but with this fresh proposal.

The second is that *Behavioural Ecology* is an important subject for Environmental Biology, Evolutionary Biology, Zoology and unspecialized Biology programs. York's biology students do not have access to this material without it. Although the Faculty of Health offers an *Animal Behaviour* course (HH/PSYC 3280), students cannot take that course without having taken the 6-credit HH/PSYC 1010 *Introduction to Psychology*, and most Faculty of Science students do not take this course. Other universities within York's catchment area recognize the importance of this material and offer courses entitled *Behavioural Ecology* (e.g. Western, Toronto, McMaster, Trent). Although York Biology's senior ecology courses are not always full (which might suggest more capacity is not needed), students in senior years who are pursuing an Environmental Biology degree or who are pursuing an ecology-evolution focus within a Biology degree sometimes to not have sufficient choice of courses.

The expected enrolment cap in this course is 50 students, given it is at the 4th year level.

Faculty and Department Approval for Cross-listings:

If the course is to be cross-listed with another department, this section needs to be signed by all parties. In some cases there may be more than two signatures required (i.e. Mathematics, Women's Studies). In the majority of the cases either the Undergraduate Director or Chair of a unit approves the agreement to cross-list. All relevant signatures must be obtained prior to submission to the Faculty curriculum committee.

Dept:	Signature (Authorizing cross-listing)	Department	Date
Dept:	Signature (Authorizing cross-listing)	Department	Date
Dept:	Signature (Authorizing cross-listing)	Department	Date

Accessible format can be provided upon request.

COMMITTEE ON ACADEMIC STANDARDS, CURRICULUM AND PEDAGOGY TEMPLATE

NEW COURSE PROPOSAL FORM

Faculty: Indicate all relevant Faculty(ies)	Science
Department: Indicate department and course prefix (e.g. Languages, GER)	Chemistry
Date of Submission:	November, 2022
Course Number: Special Topics courses Include variance (e.g. HUMA 3000C 6.0, Variance is "C")	CHEM 4055 3.0
Var:	
Academic Credit Weight: Indicate both the fee, and MTCU weight if different from academic weight (e.g. AC=6, FEE=8, MET=6	3.0
Course Title: The official name of the course as it will appear in the Undergraduate Calendar and on the Repository	Enzyme Design in Virtual Reality
Short Title: Appears on any documents where space is limited - e.g. transcripts and lecture schedules - **maximum 40 characters**	Enz. Design In VR

With every new course proposal it is the Department's responsibility to ensure that new courses do not overlap with existing courses in other units. If similarities exist, consultation with the respective departments is necessary to determine degree credit exclusions and/or cross-listed courses.

Brief Course Description:

Maximum 2000 characters
(approximately 300 words including spaces and punctuation).

The course description should be carefully written to convey what the course is about. It should be followed by a statement of prerequisites and co-requisites, if applicable. This description appears in the calendar.

For editorial consistency, and in consideration of the various uses of the Calendars, verbs should be in the present tense (i.e., "This course analyzes the nature and extent of...," rather than "This course will analyze...")

This course introduces students to the fundamental principles and modern methods of enzyme design. Foundational topics of protein structure and the mechanisms of enzymatic activity are presented in the first part of the course. The students gain new appreciation of these concepts as they examine a variety of enzyme structures in Virtual Reality (VR). The second part of the course presents the theory and practice behind modern methods of rational enzyme design, directed evolution approaches and hybrid methods. The application of these concepts is then discussed using several examples of enzymes designed for bioremediation, natural product synthesis, and biofuel production. Throughout the course, the students' learning of the topics is supported and augmented by the use of VR technology as they examine, manipulate, design, and document various aspects of these molecules.

Prerequisites: SC/CHEM 3051 3.00, SC/BIOL 3051 3.00, or SC/BCHM 3051 3.00

Generic Course Description:

This is the description of the "Parent / Generic course" for Special Topics courses under which variances of the "Generic" course can be offered in different years (Max. 40 words). Generic course descriptions are published in the calendar.

List all degree credit exclusions, prerequisites, integrated courses, and notes below the course description.

This course introduces students to the fundamental principles and modern methods of enzyme design, and discusses examples of engineered enzymes used in bioremediation, pharmaceutical industry, and for biofuel production. The students' learning in the course is supported by the use of Virtual Reality technology.

Prerequisites: SC/CHEM 3051 3.00, SC/BIOL 3051 3.00, or SC/BCHM 3051 3.00

Expanded Course Description:

Please provide a detailed course description, including topics / theories and learning objectives, as it will appear in supplemental calendars.

The course will consist of three broad modules focused on the following topics: (1) Protein structure and enzyme mechanisms; (2) Modern approaches to designing enzymes with desired activities and characteristics; (3) Application of enzyme design in bioremediation, synthesis of complex natural products and pharmaceuticals, and biofuel industry. Each module will take up approximately one third of the course (4 weeks of instruction).

The specific topics that will be covered in the course are listed below.

1.1 A detailed overview of structural elements and patterns, including secondary structures, motifs, and common domains, that are found in globular proteins.

1.2 A quantitative discussion of non-covalent interaction that underpin protein three-dimensional structure. Thermodynamics of protein folding and denaturation. Structural determinants of thermal and chemical stability.

1.3 Architecture of the active site and the energetics of substrate binding in common classes of enzymes. Transition states and induced fit.

1.4 Mechanisms of common enzymatic reactions, general acid-base catalysis, nucleophilic catalysis, electrophilic catalysis, redox catalysis. The role of water, cofactors, and coenzymes in enzymatic reactions.

2.1 A detailed discussion of how the knowledge of structure-function relationships within the enzyme active site can be leveraged to rationally design novel functionality and substrate specificity.

2.2 Directed evolution approaches in enzyme design. Saturation mutagenesis and high-throughput screening methods. Scope and limitations of directed evolution methods.

2.3 Hybrid (semi-rational) approaches to enzyme design. Discussion of basic concepts in molecular dynamics simulations, machine learning algorithms, and computational de novo design methods as applied to protein structure and function.

3.1 The scope of current and future industrial applications of engineered enzymes.

3.2 Designing enzymes for bioremediation applications. Discussion of case studies: laccase, haloalkane dehalogenase, and PETase.

3.3 Designing enzymes for the industrial synthesis of natural products and complex pharmaceuticals. Discussion of case studies: constructing monoamine oxidases for enantioselective reactions involving chiral amines, and glutaryl acylase for the efficient synthesis of cephalosporin antibiotics.

3.4 Designing enzymes for biofuel production. Discussion of case studies: designing thermostable cellulases, and organic-solvent tolerant lipases.

A List of the Course Learning Outcomes (CLOs).

Upon completion of the course, the students should be able to:

1) Explain the forces and interactions that underlie the formation of three-dimensional structures in enzyme molecules and be able to analyze structural models of enzymes in a Virtual Reality (VR) environment.
2) List the common mechanisms of enzymatic activity and relate these mechanisms to structural features of the active site and explain these features in VR.
3) List and explain the broad classes of approaches to designing novel enzyme functions and compare the advantages and disadvantages of the existing methods.
4) List and explain several specific examples of industrial applications of engineered enzymes and articulate why these applications benefit from designed enzymes as compared to traditional catalytic chemistry.
5) Discuss examples of enzymes that have been designed to perform novel functions and present the rationale for designed active site structure in the VR environment.

Course Design:

Indicate how the course design supports students in achieving the learning objectives. For example, in the absence of scheduled contact hours what role does student-to-student and/or student-to-instructor communication play, and how is it encouraged?

Detail any aspects of the content, delivery, or learning goals that involve "face-to-face" communication, non-campus attendance or experiential education components.

Alternatively, explain how the course design encourages student engagement and supports student learning in the absence of substantial on-campus attendance.

The course will consist of weekly 3-hour classes, with the first 2 hours dedicated to learning conceptual foundations and the last hour – to experiential learning in VR. We believe that this design will support and encourage student learning, creativity, and engagement by allowing each student to apply the knowledge they obtain during class in an immersive and exciting VR activity immediately following lecture. The in-class VR activities are designed as low-stakes structured exercises that a student completes guided by the instructions found on eClass (the browser will be accessed in VR). Towards the end of the semester, students will form small groups and work together in multi-used VR rooms on a common research project. The team-work aspect of this activity is also designed to enhance student engagement, build collaborative skills, and contribute to positive educational experience and success.

Instruction:

1. Planned frequency of offering and number of sections anticipated (every year, alternate years, etc.).
2. Number of department members currently competent to teach the course.
3. Instructor(s) likely to teach the course in the coming year.
4. An indication of the number of contact hours (defined in terms of hours, weeks, etc.) involved, in order to indicate whether an effective length of term is being maintained **OR** in the absence of scheduled contact hours a detailed breakdown of the estimated time students are likely to spend engaged in learning activities required by the course.

The proposed course will be offered in the fall term once every year. There will be one section.

Several faculty members (see below) in the department of chemistry are competent to teach the course.

The first offering of the course is projected to take place in the Fall'24 semester. The instructors that can teach the course are Drs. Derek Wilson, Philip Johnson, Ryan Hili, Kyle Belozerov and Derek Jackson.

The course will consist of 3 contact hours per week and 3 hours of study and group work outside of the classroom per week. Each 3-hour lecture will consist of 2 hours of traditional instruction followed by 1 hour of experiential learning using VR technology.

Evaluation:

A detailed percentage breakdown of the basis of evaluation in the proposed course must be provided.

If the course is to be integrated, the additional requirements for graduate students are to be listed.

If the course is amenable to technologically mediated forms of delivery please identify how the integrity of learning evaluation will be maintained. (e.g. will "on-site" examinations be required, etc.)

1. Weekly in-class VR activity (10 total): 20% (CLOs 1-5)
2. Midterm exam: 20% (CLOs 1-3)
3. Peer-assessed written assignment: 10% (CLO 5)
4. Group research project: 20% (CLO 5, VR presentation)
5. Final Exam: 30% (CLOs 1-5)

Bibliography:

A READING LIST MUST BE INCLUDED FOR ALL NEW COURSES

The Library has requested that the reading list contain complete bibliographical information, such as full name of author, title, year of publication, etc., and that you distinguish between required and suggested readings. A statement is required from the bibliographer responsible for the discipline to indicate whether resources are adequate to support the course.

Also please list any online resources.

If the course is to be integrated (graduate/ undergraduate), a list of the additional readings to be required of graduate students must be included. If no additional readings are to be required, a rationale should be supplied.

LIBRARY SUPPORT STATEMENT MUST BE INCLUDED.

The course will use a popular introductory text “Fundamentals of Enzyme Engineering”, 1st ed. (2017) by Young Je Yoo, Yan Feng, Yong-Hwan Kim, and Camila Flor J. Yagonia
ISBN-13: 978-9402410242
The textbook will be available at the York University bookstore and at the Steacie Science library.

In addition to the textbook, three recent review articles will be discussed in class:

1. Galanie S, Entwistle D, Lalonde J. Engineering biosynthetic enzymes for industrial natural product synthesis. Nat Prod Rep. 2020 Aug 19;37(8):1122-1143.

2. Nezhad NG, Rahman RNZRA, Normi YM, Oslan SN, Shariff FM, Leow TC. Thermostability engineering of industrial enzymes through structure modification. Appl Microbiol Biotechnol. 2022 Aug;106(13-16):4845-4866.

3. Feehan R, Montezano D, Slusky JSG. Machine learning for enzyme engineering, selection and design. Protein Eng Des Sel. 2021 Feb 15;34:gzab019.

All three articles are available to York students through the library. The letter of support from the Steacie Science Library is attached.

Other Resources:

A statement regarding the adequacy of physical resources (equipment, space, etc.) must be appended. If other resources will be required to mount this course, please explain

COURSES WILL NOT BE APPROVED UNLESS IT IS CLEAR THAT ADEQUATE RESOURCES ARE AVAILABLE TO SUPPORT IT.

A standard classroom equipped with a projector is required to deliver the course. The VR headsets will be made available for the students by the VR Learning Facility that is currently being set up in the department of chemistry (funded by the AIF Category I grant to D. Jackson and K. Belozerov). The professor and a teaching assistant can transport the VR headsets (Meta Quest 2) to and from the classroom.

Course Rationale:

The following points should be addressed in the rationale:

How the course contributes to the learning objectives of the program / degree.

The relationship of the proposed course to other existing offerings, particularly in terms of overlap in objectives and/or content. If inter-Faculty overlap exists, some indication of consultation with the Faculty affected should be given.

The expected enrolment in the course.

Enzymes are macromolecular (mostly protein) catalysts characterized by unparalleled capacity to accelerate chemical reactions while maintaining near-complete regio- and stereo-selectivity. These unique properties of enzymes are actively pursued in chemical and pharmaceutical industry in an effort to reduce the production costs and environmental footprint of chemical manufacture. In recent years, numerous examples of enzymes specifically designed for otherwise unattainable industrial applications appeared in the literature and in patents. This trend is certain to expand and accelerate in the future as methods for the efficient design of novel enzymatic activities and characteristics become more developed. Therefore, an introduction to the field of enzyme design would be a useful component in the training of a 21st-century chemist aiming to enter the dynamic world of chemical industry.

Currently, the faculty of science, and the department of chemistry in particular, do not offer a course that would introduce the students to the principles and practice of enzyme design. The proposed course, CHEM4055, will serve as a theoretical introduction to the topic and will expose students to many interesting examples of enzymes engineered for industrial applications. As the function of an enzyme is fully determined by its structure, the students' appreciation of structural design principles will be greatly augmented by the extensive use of Virtual Reality technology in the course.

The learning goal of the course is to help the students develop a solid understanding of the enzyme structural features, both in the active site and elsewhere in the molecule, that underlie catalytic activity and physical properties

needed for a specific industrial application. CHEM4055 will be the first course in the Faculty of Science designed to fully integrate the VR technology into classroom activities and student independent work. The experience of working in a VR environment is a valuable transferrable skill that the students in the course will gain.

The expected enrolment in the course: up to 75 students from the departments of Chemistry and Biology may enroll in the course.

Faculty and Department Approval for Cross-listings:

If the course is to be cross-listed with another department, this section needs to be signed by all parties. In some cases there may be more than two signatures required (i.e. Mathematics, Women's Studies). In the majority of the cases either the Undergraduate Director or Chair of a unit approves the agreement to cross-list. All relevant signatures must be obtained prior to submission to the Faculty curriculum committee.

Upon consultation with the Department of Biology UPD and teaching committee, it was decided that the course should be cross-listed with BCHM. The Biology teaching committee approved cross-listing on May 8, 2023.

Dept:	DJackson	Chemistry	May 8, 2023
	Signature (Authorizing cross-listing)	Department	Date
Dept:	Nicole Nivillac Digitally signed by Nicole Nivillac DN: cn=Nicole Nivillac, c=CA, o=York University, ou=Department of Biology, email=nivillac@yorku.ca Date: 2023.05.09 11:55:56 -04'00'	Biology (BCHM)	May 9, 2023
	Signature (Authorizing cross-listing)	Department	Date
Dept:			
	Signature (Authorizing cross-listing)	Department	Date

Accessible format can be provided upon request.

STEACIE SCIENCE & ENGINEERING LIBRARY
YORK UNIVERSITY

MEMORANDUM

To:	Kyle Belozerov, Assistant Professor, Chemistry Department
From:	Minglu Wang, Science Librarian
Re:	CHEM 4055 – Enzyme Design in Virtual Reality
Date:	October 18, 2022

I have reviewed the course proposal for **CHEM 4055 – Enzyme Design in Virtual Reality** and can state that the York University Libraries have the required resources to support this course.

Please be aware that the library offers the following services to help students with their research:

- A librarian is also available for individual consultations, both face-to-face and online, with students to help them find the materials they need for their projects. Research appointments can made at https://yorku.libcal.com/appointments/hse
- A librarian can create a custom workshop tailored to the course. Content can include both introductory and in-depth instruction on searching for chemical information in SciFinder, Reaxys, Web of Science, Scopus, and elsewhere. Reference management using software such as Mendeley and Zotero can also be introduced. If needed, please fill out the Library Class Request Form,
- A custom online research guide tailored to the course can be created upon request.

Full text articles from the following journals mentioned in the course proposal are currently available through York University Libraries' electronic databases:

- *Natural Product Reports*
- *Applied microbiology and biotechnology*
- *Protein engineering, design & selection*

An eBook copy of the following textbook is also available through York University Libraries:

- Yoo, Young Je et al. *Fundamentals of Enzyme Engineering*. Dordrecht, The Netherlands: Springer, 2017.

If later a more complete bibliography could be provided, our Collection Development and Analysis Department could search the bibliography against our library collection. We will try to ensure that we have at least one copy of every book listed in the bibliography. Where possible and affordable, eBooks will be purchased with unlimited users. If there are multiple articles from a journal in the required reading that we do not have, we will investigate a subscription.

E-resource permalinks can be embedded in the course learning management system, ex. Canvas or eClass. Please consult the library's Creating Permalinks for EResources Guide for more information.

STEACIE SCIENCE & ENGINEERING LIBRARY
YORK UNIVERSITY

MEMORANDUM

The following electronic resources licensed by the library may be of help to the students in this course:

- **SciFinder**
- **Reaxys**
- **Web of Science**
- **Scopus**

In summary, I state that we are well positioned to support this course. If you have any questions, please do not hesitate to contact me.

Sincerely,

Minglu Wang, Physical Sciences Librarian
Steacie Science & Engineering Library
416-736-2100 x40075 mingluwa@yorku.ca

November 21, 2022

Chemistry Undergraduate Program Director Statement of Support for New Course Proposal CHEM 4055: Enzyme Design in Virtual Reality

Our Biochemistry program is expanding. Currently, it is the second fastest growing program in the Faculty of Science. Therefore, we are planning to introduce new biochemistry-oriented course offerings, especially at the 3000- and 4000-level, in the coming years. CHEM4055 is a new course in this category. It will offer our Biochemistry majors a new and modern fourth-year course to help satisfy their upper-year degree requirements. Enzyme design and engineering is a very important topic in biochemical research today, and currently there are no courses offered by our Faculty specifically devoted to enzymes.

This new course will also make extensive use of virtual reality (VR) technology to augment student learning. To date, our department has successfully used VR headsets in both first and third-year courses to greatly improve student understanding of molecular structure and function. Currently, the Chemistry Department owns more than 30 Meta Quest 2 VR headsets and we have the funding (from AIF and other grants) to purchase another set of 30-50 headsets, making the total exceed the expected maximum enrollment for CHEM 4055. Over the past two years, we have extensively tested the VR technology in various classrooms on Keele campus and found that any WiFi enabled classroom can be used for stable operation of the headsets. Further, we worked out facile systems for software and content management of the headsets in out VR lab, which will ensure our ability to centrally upload the necessary resources to individual headsets or groups of headsets. These, and many other field-tested headset management protocols, will allow us to minimize the TA resources necessary to run the course. Indeed, the course will need only 33.75 hours of TA support.

The course proposal was designed by Dr. Kyle Belozerov, who already has extensive experience in the instruction of VR technology to a wide range of students, from elementary school students to third-year undergraduates. There are at least three additional full-time faculty members in our department who can teach this course. Some of these faculty members already have sufficient previous VR experience with the software to be used in the course. Any other faculty members interested in teaching the course will have access to instructional materials and VR manuals developed by myself, Dr. Belozerov, and our collaborators over the course of past two years. Our department already has considerable experience in training teaching assistants to use the Quest 2 headsets and the molecular visualization software to be used in CHEM4055. Therefore, we are ready to provide short and efficient training to the prospective TAs.

No significant additional resources are needed to offer this new course. A statement of support from the Steacie Science Library is attached which confirms the availability of the course textbook and required readings.

The Department of Chemistry has approved this new course proposal at the departmental meeting on October 20, 2022. We look forward to offering this new course as soon as possible so our students can reap the proven benefits of VR technology in improving their understanding of macromolecular structure and function. As an added benefit, after completing the course, the students will become

confident users of VR for biochemical research. Based on the documented trends of VR applications in a variety of biotechnology and pharmaceutical industries, we view the students' experience in CHEM4055 as a valuable transferrable skill that is certain to benefit them as they pursue careers in these dynamic industries.

In summary, I enthusiastically support this proposed new course and look forward to offering our students this exciting new educational experience.

Best wishes,

Derek Jackson

Undergraduate Program Director

Department of Chemistry

FS Resource Implications Form **Unit: _Chemistry_** **Date: _November 21, 2022_**

		Course(s) Created ☒ or Modified to ☐ (check one)		Course(s) Retired ☐ or Modified from ☐
Complete Course Designation		CHEM 4055 3.0 Enzyme Design in Virtual Reality		
Enrolment (Estimate or Last Offering)		50		
Number of:	**Lecture Sections:**	1		
	Lab Sections:	0		
	Tutorial Sections:	0		
Number of:	**Course Coordinators (Tutor 1):**	0		
	Lab Demonstrators (Tutor 2):	0.125 TAship (33.75 hours)		
	Mark/Graders (Tutor 3):	0		
Prerequisites (P) Corequisites (C) Credit Exclusions (E)		SC/CHEM 3051 3.00, SC/BIOL 3051 3.00, or SC/BCHM 3051 3.00 (P)		
For which degree program is this required (if applicable)?		N/A		
Other resource implications (please specify)		VR Headsets (already available in the department of Chemistry)		
Reason(s) for creation/ modification/ retirement		Currently, the faculty of science, and the department of chemistry in particular, do not offer a course that would introduce the students to the principles and practice of enzyme design. The proposed course, CHEM4055, will serve as a theoretical introduction to the topic and will expose students to many interesting examples of enzymes engineered for industrial applications. The learning goal of the course is to help the students develop a solid understanding of the enzyme structural features, both in the active site and elsewhere in the molecule, that underlie catalytic activity and physical properties needed for a specific industrial application. CHEM4055 will be the first course in the Faculty of Science designed to fully integrate the VR technology into classroom activities and student independent work. The experience of working in a VR environment is a valuable transferrable skill that the students in the course will gain.		

Changes to Existing Course

Faculty:

Department: Mathematics & Statistics

Date of Submission: April 2023

Course Number: Math3901 0.00

Effective Session: Summer 2023

Course Title: **Mathematic and Statistics Internship Work Term**

Type of Change:

- [X] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [ ]

Change From:	**To:**
Prerequisites: Enrollment is by permission only. Criteria for permission include: (1) that students have a cumulative GPA and an average of math GPA of at least 7.5; (2) that Applied Mathematics students have successfully completed SC/MATH 3241 3.00, SC/MATH 3271 3.00 and at least one of one SC/MATH 3242 3.00, SC/MATH 3260 3.00, SC/MATH 3171 3.00 and SC/MATH 3172 3.00; that Pure Mathematics students have successfully completed at least two of SC/MATH 3001 3.00, SC/MATH 3010 3.00 and SC/MATH 3021 3.00; that Statistics students have successfully completed SC/MATH 3131 3.00, SC/MATH 3330 3.00, SC/MATH 3132 3.00, SC/MATH 3430 3.00; that Actuarial Science students have successfully completed SC/MATH 2280 3.00, SC/MATH 2281 3.00, SC/MATH 2131 3.00 and passed at least one professional exam; that Mathematics for Education students have successfully completed SC/MATH 3052 3.00; (3) that students are enrolled full-time in the Honours or Specialized Honours program; (4) that students have not been absent for more than two consecutive years as a full-time student from their Honours or Specialized Honours degree studies; (5) that upon enrolling in their course students have a minimum of nine credits remaining toward their degree and need to return as a full-time student for at least one academic term to complete their degree after completion of their final work term. Note: This is a pass/fail course.	Prerequisites: Enrollment is by permission only. Criteria for permission include: (1) that Applied Mathematics, Pure Mathematics, Actuarial Science and Mathematics for Education students have a cumulative GPA and an average Math GPA of at least 6.0, and that Statistics students have a cumulative GPA and an average Math GPA of at least 6.5; (2) that Applied Mathematics students have successfully completed SC/MATH 3241 3.00, SC/MATH 3271 3.00 and at least one of one SC/MATH 3242 3.00, SC/MATH 3260 3.00, SC/MATH 3171 3.00 and SC/MATH 3172 3.00; that Pure Mathematics students have successfully completed at least two of SC/MATH 3001 3.00, SC/MATH 3010 3.00 and SC/MATH 3021 3.00; that Statistics students have successfully completed SC/MATH 3131 3.00, SC/MATH 3330 3.00, SC/MATH 3132 3.00, SC/MATH 3430 3.00; that Actuarial Science students have successfully completed SC/MATH 2280 3.00, SC/MATH 2281 3.00, SC/MATH 2131 3.00 and passed at least one professional exam; that Mathematics for Education students have successfully completed SC/MATH 3052 6.00; (3) that students are enrolled full-time in the Honours or Specialized Honours program; (4) that students have not been absent for more than two consecutive years as a full-time student from their Honours or Specialized Honours degree studies; (5) that upon enrolling in their course students have a minimum of nine credits remaining toward their degree and need to return as a full-time student for at least one academic term to complete their degree after completion of their final work term. Note: This is a pass/fail course.

Rationale:

This lowering of the required GPA for enrollment will allow more of our students to qualify for an internship. Under the current requirements, only 3 students entering third year (excluding Math Ed) qualifies for this course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department: Mathematics & Statistics

Date of Submission: April 2023

Course Number: Math3902 0.00

Effective Session: Summer 2023

Course Title: **Mathematic and Statistics Internship Work Term**

Type of Change:

- [X] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [ ]

Change From:	**To:**
Prerequisites: Enrollment is by permission only. Criteria for permission include: (1) that students have a cumulative GPA and an average of math GPA of at least 7.5; (2) that Applied Mathematics students have successfully completed SC/MATH 3241 3.00, SC/MATH 3271 3.00 and at least one of one SC/MATH 3242 3.00, SC/MATH 3260 3.00, SC/MATH 3171 3.00 and SC/MATH 3172 3.00; that Pure Mathematics students have successfully completed at least two of SC/MATH 3001 3.00, SC/MATH 3010 3.00 and SC/MATH 3021 3.00; that Statistics students have successfully completed SC/MATH 3131 3.00, SC/MATH 3330 3.00, SC/MATH 3132 3.00, SC/MATH 3430 3.00; that Actuarial Science students have successfully completed SC/MATH 2280 3.00, SC/MATH 2281 3.00, SC/MATH 2131 3.00 and passed at least one professional exam; that Mathematics for Education students have successfully completed SC/MATH 3052 3.00; (3) that students are enrolled full-time in the Honours or Specialized Honours program; (4) that students have not been absent for more than two consecutive years as a full-time student from their Honours or Specialized Honours degree studies; (5) that upon enrolling in their course students have a minimum of nine credits remaining toward their degree and need to return as a full-time student for at least one academic term to complete their degree after completion of their final work term. Note: This is a pass/fail course.	Prerequisites: Enrollment is by permission only. Criteria for permission include: (1) that Applied Mathematics, Pure Mathematics, Actuarial Science and Mathematics for Education students have a cumulative GPA and an average Math GPA of at least 6.0, and that Statistics students have a cumulative GPA and an average Math GPA of at least 6.5; (2) that Applied Mathematics students have successfully completed SC/MATH 3241 3.00, SC/MATH 3271 3.00 and at least one of one SC/MATH 3242 3.00, SC/MATH 3260 3.00, SC/MATH 3171 3.00 and SC/MATH 3172 3.00; that Pure Mathematics students have successfully completed at least two of SC/MATH 3001 3.00, SC/MATH 3010 3.00 and SC/MATH 3021 3.00; that Statistics students have successfully completed SC/MATH 3131 3.00, SC/MATH 3330 3.00, SC/MATH 3132 3.00, SC/MATH 3430 3.00; that Actuarial Science students have successfully completed SC/MATH 2280 3.00, SC/MATH 2281 3.00, SC/MATH 2131 3.00 and passed at least one professional exam; that Mathematics for Education students have successfully completed SC/MATH 3052 6.00; (3) that students are enrolled full-time in the Honours or Specialized Honours program; (4) that students have not been absent for more than two consecutive years as a full-time student from their Honours or Specialized Honours degree studies; (5) that upon enrolling in their course students have a minimum of nine credits remaining toward their degree and need to return as a full-time student for at least one academic term to complete their degree after completion of their final work term. Note: This is a pass/fail course.

Rationale:

This lowering of the required GPA for enrollment will allow more of our students to qualify for an internship. Under the current requirements, only 3 students entering third year (excluding Math Ed) qualifies for this course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department: Mathematics & Statistics

Date of Submission: April 2023

Course Number: Math3903 0.00

Effective Session: Summer 2023

Course Title: **Mathematic and Statistics Internship Work Term**

Type of Change:

- [X] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [ ]

Change From:	**To:**
Prerequisites: Enrollment is by permission only. Criteria for permission include: (1) that students have a cumulative GPA and an average of math GPA of at least 7.5; (2) that Applied Mathematics students have successfully completed SC/MATH 3241 3.00, SC/MATH 3271 3.00 and at least one of one SC/MATH 3242 3.00, SC/MATH 3260 3.00, SC/MATH 3171 3.00 and SC/MATH 3172 3.00; that Pure Mathematics students have successfully completed at least two of SC/MATH 3001 3.00, SC/MATH 3010 3.00 and SC/MATH 3021 3.00; that Statistics students have successfully completed SC/MATH 3131 3.00, SC/MATH 3330 3.00, SC/MATH 3132 3.00, SC/MATH 3430 3.00; that Actuarial Science students have successfully completed SC/MATH 2280 3.00, SC/MATH 2281 3.00, SC/MATH 2131 3.00 and passed at least one professional exam; that Mathematics for Education students have successfully completed SC/MATH 3052 3.00; (3) that students are enrolled full-time in the Honours or Specialized Honours program; (4) that students have not been absent for more than two consecutive years as a full-time student from their Honours or Specialized Honours degree studies; (5) that upon enrolling in their course students have a minimum of nine credits remaining toward their degree and need to return as a full-time student for at least one academic term to complete their degree after completion of their final work term. Note: This is a pass/fail course.	Prerequisites: Enrollment is by permission only. Criteria for permission include: (1) that Applied Mathematics, Pure Mathematics, Actuarial Science and Mathematics for Education students have a cumulative GPA and an average Math GPA of at least 6.0, and that Statistics students have a cumulative GPA and an average Math GPA of at least 6.5; (2) that Applied Mathematics students have successfully completed SC/MATH 3241 3.00, SC/MATH 3271 3.00 and at least one of one SC/MATH 3242 3.00, SC/MATH 3260 3.00, SC/MATH 3171 3.00 and SC/MATH 3172 3.00; that Pure Mathematics students have successfully completed at least two of SC/MATH 3001 3.00, SC/MATH 3010 3.00 and SC/MATH 3021 3.00; that Statistics students have successfully completed SC/MATH 3131 3.00, SC/MATH 3330 3.00, SC/MATH 3132 3.00, SC/MATH 3430 3.00; that Actuarial Science students have successfully completed SC/MATH 2280 3.00, SC/MATH 2281 3.00, SC/MATH 2131 3.00 and passed at least one professional exam; that Mathematics for Education students have successfully completed SC/MATH 3052 6.00; (3) that students are enrolled full-time in the Honours or Specialized Honours program; (4) that students have not been absent for more than two consecutive years as a full-time student from their Honours or Specialized Honours degree studies; (5) that upon enrolling in their course students have a minimum of nine credits remaining toward their degree and need to return as a full-time student for at least one academic term to complete their degree after completion of their final work term. Note: This is a pass/fail course.

Rationale:

This lowering of the required GPA for enrollment will allow more of our students to qualify for an internship. Under the current requirements, only 3 students entering third year (excluding Math Ed) qualifies for this course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department: Mathematics & Statistics

Date of Submission: April 2023

Course Number: Math3904 0.00

Effective Session: Summer 2023

Course Title: **Mathematic and Statistics Internship Work Term**

Type of Change:

- [X] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [ ]

Change From:	**To:**
Prerequisites: Enrollment is by permission only. Criteria for permission include: (1) that students have a cumulative GPA and an average of math GPA of at least 7.5; (2) that Applied Mathematics students have successfully completed SC/MATH 3241 3.00, SC/MATH 3271 3.00 and at least one of one SC/MATH 3242 3.00, SC/MATH 3260 3.00, SC/MATH 3171 3.00 and SC/MATH 3172 3.00; that Pure Mathematics students have successfully completed at least two of SC/MATH 3001 3.00, SC/MATH 3010 3.00 and SC/MATH 3021 3.00; that Statistics students have successfully completed SC/MATH 3131 3.00, SC/MATH 3330 3.00, SC/MATH 3132 3.00, SC/MATH 3430 3.00; that Actuarial Science students have successfully completed SC/MATH 2280 3.00, SC/MATH 2281 3.00, SC/MATH 2131 3.00 and passed at least one professional exam; that Mathematics for Education students have successfully completed SC/MATH 3052 3.00; (3) that students are enrolled full-time in the Honours or Specialized Honours program; (4) that students have not been absent for more than two consecutive years as a full-time student from their Honours or Specialized Honours degree studies; (5) that upon enrolling in their course students have a minimum of nine credits remaining toward their degree and need to return as a full-time student for at least one academic term to complete their degree after completion of their final work term. Note: This is a pass/fail course.	Prerequisites: Enrollment is by permission only. Criteria for permission include: (1) that Applied Mathematics, Pure Mathematics, Actuarial Science and Mathematics for Education students have a cumulative GPA and an average Math GPA of at least 6.0, and that Statistics students have a cumulative GPA and an average Math GPA of at least 6.5; (2) that Applied Mathematics students have successfully completed SC/MATH 3241 3.00, SC/MATH 3271 3.00 and at least one of one SC/MATH 3242 3.00, SC/MATH 3260 3.00, SC/MATH 3171 3.00 and SC/MATH 3172 3.00; that Pure Mathematics students have successfully completed at least two of SC/MATH 3001 3.00, SC/MATH 3010 3.00 and SC/MATH 3021 3.00; that Statistics students have successfully completed SC/MATH 3131 3.00, SC/MATH 3330 3.00, SC/MATH 3132 3.00, SC/MATH 3430 3.00; that Actuarial Science students have successfully completed SC/MATH 2280 3.00, SC/MATH 2281 3.00, SC/MATH 2131 3.00 and passed at least one professional exam; that Mathematics for Education students have successfully completed SC/MATH 3052 6.00; (3) that students are enrolled full-time in the Honours or Specialized Honours program; (4) that students have not been absent for more than two consecutive years as a full-time student from their Honours or Specialized Honours degree studies; (5) that upon enrolling in their course students have a minimum of nine credits remaining toward their degree and need to return as a full-time student for at least one academic term to complete their degree after completion of their final work term. Note: This is a pass/fail course.

Rationale:

This lowering of the required GPA for enrollment will allow more of our students to qualify for an internship. Under the current requirements, only 3 students entering third year (excluding Math Ed) qualifies for this course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Physics and Astronomy	**Date of Submission:**	Winter 2023
Course Number:	SC/PHYS 3070 3.0	**Effective Session:**	Fall 2024
Course Title:	Planets and Planetary Systems		

Type of Change:

[X]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisite: SC/PHYS 1010 6.00, or SC/PHYS 1800 3.00 and SC/PHYS 1801 3.00, or SC/ISCI 1310 6.0, or a minimum grade of C in SC/PHYS 1410 6.00 or SC/PHYS 1420 6.00.	Prerequisites: SC/PHYS 1011 3.00 and SC/PHYS 1012 3.00, or SC/PHYS 1800 3.00 and SC/PHYS 1801 3.00, or SC/ISCI 1301 3.00 and SC/ISCI 1302 3.00, or a minimum grade of C in SC/PHYS 1411 3.00 and SC/PHYS 1412 3.00, or SC/PHYS 1421 3.00 and SC/PHYS 1422 3.00.

Rationale:

PHYS 1010 6.0, PHYS 1410 6.0, PHYS 1420 6.0 and ISCI 1310 6.0 have each been split into two 3.0 credit courses.
Simliar changes to physics courses referencing 1000-level PHYS prerequisites happened previously, but this 3000-level course was missed.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

COMMITTEE ON ACADEMIC STANDARDS, CURRICULUM AND PEDAGOGY TEMPLATE

NEW COURSE PROPOSAL FORM

Faculty: Indicate all relevant Faculty(ies)	Science
Department: Indicate department and course prefix (e.g. Languages, GER)	Biology
Date of Submission:	June 2023
Course Number: Special Topics courses Include variance (e.g. HUMA 3000C 6.0, Variance is "C")	BIOL3095 3.0
Var:	
Academic Credit Weight: Indicate both the fee, and MTCU weight if different from academic weight (e.g. AC=6, FEE=8, MET=6	3.0
Course Title: The official name of the course as it will appear in the Undergraduate Calendar and on the Repository	Introduction to Bioinformatics
Short Title: Appears on any documents where space is limited - e.g. transcripts and lecture schedules - **maximum 40 characters**	Introduction to Bioinformatics

With every new course proposal it is the Department's responsibility to ensure that new courses do not overlap with existing courses in other units. If similarities exist, consultation with the respective departments is necessary to determine degree credit exclusions and/or cross-listed courses.

Brief Course Description:

Maximum 2000 characters
(approximately 300 words including spaces and punctuation).

The course description should be carefully written to convey what the course is about. It should be followed by a statement of prerequisites and co-requisites, if applicable. This description appears in the calendar.

For editorial consistency, and in consideration of the various uses of the Calendars, verbs should be in the present tense (i.e., "This course analyzes the nature and extent of...," rather than "This course will analyze...")

Bioinformatics is the field of study focused on the analysis and interpretation of biological data using computer software tools, as well as the development of new approaches, methods, and software used to analyze that data. This course provides an introduction to the different types of biological data that can be analyzed using a bioinformatics approach, and the current methods and tools that are used in those analyses. This will include the basic theoretical and practical background needed to select, understand, and implement computational approaches to tackle specific biological and medical problems, particularly with respect to biological sequence data (DNA, RNA, and protein). Skills in Linux computing and scripting in Bash, R, and Python will be acquired. Case studies will be used to illustrate the applications of bioinformatics to biological and medical research.

Pre-requisites: SC/BIOL 3.00 2040 *Genetics* and one of: SC/BIOL 2060 3.00 *Statistics for Biologists*, MATH2030 3.0 *Elementary Probability*, MATH 2131 3.0 *Introduction to Statistics II*.

Generic Course Description:

This is the description of the “Parent / Generic course” for Special Topics courses under which variances of the “Generic” course can be offered in different years (Max. 40 words). Generic course descriptions are published in the calendar.

List all degree credit exclusions, prerequisites, integrated courses, and notes below the course description.

Expanded Course Description:

Please provide a detailed course description, including topics / theories and learning objectives, as it will appear in supplemental calendars.

Technological advances are driving a rapid and continued expansion in the production of biological data to the point that the storage, access, and analysis of this data has become one of the primary bottlenecks in biological and medical research. Overcoming this bottleneck requires leveraging a combination of informational, computational, and algorithmic approaches with an understanding of biological processes. It is to this that the field of bioinformatics is devoted, and as a result bioinformatics has become an integral component of the biological and medical research enterprise.

This course provides students with a working knowledge of the different types of biological data that can be analyzed using a bioinformatics approach, and the current methods and tools that are used in those analyses. This will include the basic theoretical and practical background needed to select, understand, and implement computational approaches to tackle specific biological and medical problems. Concepts, approaches, and advances in bioinformatics are introduced during lectures, and those concepts are applied to build, curate, and analyze biological datasets during labs. Skills in Linux computing and scripting in Bash, R, and Python will be acquired. Emphasis is given to biological sequence data (DNA, RNA, and protein).

Potential topics to be covered:

- What is informatics and how can it be applied to biological data?
- How do we store and retrieve biological data?
- How can we produce biological datasets from new and existing data sources?
- What are the methods for sequencing DNA and genomes and how can we analyze that data?
- What information can we gain from RNA and how do we produce and analyze that data?
- How can we use biological sequences to study evolution?
- How can we identify proteins and predict their structure and function?
- How do the medical and biotechnology fields apply bioinformatics?
- What are some of the most recent advances in bioinformatics and how are they moving the field forward?
- What are some ethical concerns of bioinformatics approaches and how might these be mitigated?

Learning objectives:

Upon successful completion of this course, students are expected to be able to:

- Describe the link between informatics and biology.
- Identify the types of biological data that can be analyzed using informatics approaches.
- Locate appropriate biological databases and use them to retrieve data needed to answer biological questions.

- Determine the tools needed to analyze different types of biological data.
- Manipulate and analyze biological data within a Linux command line environment including the automation of simple tasks through basic scripting (Bash, R, Python).
- Describe the algorithms and statistical approaches underlying common bioinformatics tools.
- Effectively communicate a bioinformatics approach to answering specific biological questions.
- Apply common bioinformatics tools to analyze biological datasets.
- Interpret and communicate the results of bioinformatic analyses.
- Reflect on the societal impact of bioinformatics as it can be applied to the medical and biotechnology sectors.
- Reflect on and effectively communicate new bioinformatics approaches and how they can overcome limitations of the field.

Course Design:

Indicate how the course design supports students in achieving the learning objectives. For example, in the absence of scheduled contact hours what role does student-to-student and/or student-to-instructor communication play, and how is it encouraged?

Detail any aspects of the content, delivery, or learning goals that involve "face-to-face" communication, non-campus attendance or experiential education components.

Alternatively, explain how the course design encourages student engagement and supports student learning in the absence of substantial on-campus attendance.

Course Design

The course consists of a lecture component where concepts and approaches in bioinformatics are introduced and a lab component where those concepts are applied to build, curate, and analyze biological datasets. Lectures may include guest speaker bioinformaticians from academia, industry, and government.

The course supports the achievement of the learning objectives by providing foundational and theoretical knowledge of bioinformatics approaches and tools via lectures and application of those approaches/tools during hands-on computer labs. This will be facilitated by the Course Director and small group discussions during lectures and office hours and by TAs during labs sessions.

The use of case studies in lecture material, as well as supplemental readings, will reinforce the foundational, theoretical, and applied instruction, and provide students with experiential learning opportunities.

Experiential Learning

Students will assemble and analyze biological datasets through the application of various bioinformatics techniques and tools during their laboratory experiments. Students will draw on the knowledge and concepts being taught in class, critically reflect on the new material, and communicate their understanding of bioinformatics practices through their lab assignments. Each lab will introduce students to the techniques and tools needed to perform bioinformatics analyses based on a topic previously covered in the lectures.

Students will also engage in experiential learning through exploring case studies in bioinformatics in class. Students will work both individually and in groups to address the questions “what?” (e.g., what did they learn about the material covered), “so what?” (how does this information contribute to our knowledge in the field of bioinformatics), and “what now?” (what more would they like to know and how can this information be applied to biological and/or medical research). This activity should encourage reflection on the integration of key course concepts.

The guest lectures will provide students with real world exposure to bioinformaticians employed in different sectors and thus the different career paths that are available to pursue.

Instruction:

1. Planned frequency of offering and number of sections anticipated (every year, alternate years, etc.).
2. Number of department members currently competent to teach the course.
3. Instructor(s) likely to teach the course in the coming year.
4. An indication of the number of contact hours (defined in terms of hours, weeks, etc.) involved, in order to indicate whether an effective length of term is being maintained **OR** in the absence of scheduled contact hours a detailed breakdown of the estimated time students are likely to spend engaged in learning activities required by the course.

1. Annually in the Fall or Winter semester at Keele Campus.

2. At least three Biology faculty could teach the course.

3. Ryan Schott.

4. Two lecture hours and three lab hours per week. 12 weeks. One semester.

Evaluation:

A detailed percentage breakdown of the basis of evaluation in the proposed course must be provided.

If the course is to be integrated, the additional requirements for graduate students are to be listed.

If the course is amenable to technologically mediated forms of delivery please identify how the integrity of learning evaluation will be maintained. (e.g. will "on-site" examinations be required, etc.)

To incorporate the principles of universal design for learning (i.e., flexible, accessible, choice), the final grade for the course will be based on the following:

Lab Assignments (10 x 5%, lowest dropped): 45%
Journal Reflections (6 x 3%, lowest dropped): 15%
Biweekly Quizzes (6 x 3%, lowest dropped): 15%
Final Exam = 15%
Lab Exam = 10%

Formative assessments will be conducted through biweekly quizzes, lab assignments, and journal reflections. Biweekly quizzes will assess material from the previous weeks' lectures, helping students to keep up with the material while providing feedback to both students and the Course Director. Each lab will culminate with an assignment that students can begin during that lab session and submit prior to the start of the next lab. These lab assignments provide students the opportunity to apply the skills they have just learned. As well, students will write short journal reflections following in-class small group case study discussions and guest lectures.

Summative assessments will consist of a final exam and a final lab exam. The final exam will be primarily short answer questions to assess students' foundational and theoretical knowledge of bioinformatics concepts and ability to provide bioinformatics solutions to biological problems. The lab exam will assess students' ability to use bioinformatics approaches and tools to produce and analyze biological datasets to answer biological research questions. The lab exam will be administered during the final regularly scheduled lab time.

Bibliography:

A READING LIST MUST BE INCLUDED FOR ALL NEW COURSES

The Library has requested that the reading list contain complete bibliographical information, such as full name of author, title, year of publication, etc., and that you distinguish between required and suggested readings. A statement is required from the bibliographer responsible for the discipline to indicate whether resources are adequate to support the course.

Also please list any online resources.

If the course is to be integrated (graduate/ undergraduate), a list of the additional readings to be required of graduate students must be included. If no additional readings are to be required, a rationale should be supplied.

LIBRARY SUPPORT STATEMENT MUST BE INCLUDED.

Two textbooks are being considered for use in the course:

Introduction to Bioinformatics 5/e
Arthur Lesk
ISBN-13: 9780198794141
Copyright Year: 2019 | Fifth Edition | 440 pp.

Concepts in Bioinformatics and Genomics
Jamil Momand and Alison McCurdy
ISBN-13: 9780199936991
Copyright Year: 2017 | 560 pp.

Journals that may be used for case studies and to highlight recent advances in bioinformatics:

- Advances in Bioinformatics
- Bioinformatics
- Bioinformatics and Biology Insights
- BMC Bioinformatics
- *Briefings in Bioinformatics*
- Comparative and Functional Genomics
- Computational Biology and Chemistry
- Computational Molecular Bioscience
- Database: The Journal of Biological Databases & Curation
- Evolutionary Bioinformatics
- Genomics
- Genomics, Proteomics & Bioinformatics
- Genome Research
- Genome Biology and Evolution
- GigaScience
- Transactions on Computational Biology and Bioinformatics
- International Journal of Bioinformatics Research and Applications
- *In Silico* Biology
- Journal of Bioinformatics and Computational Biology
- Journal Computational Biology
- Journal of Mathematical Biology
- Journal of Molecular Evolution
- Journal of Proteomics and Bioinformatics
- Journal of Structural and Functional Genomics
- Journal of Theoretical Biology
- Molecular Phylogenetics and Evolution
- Nucleic Acids Research
- Online Journal of Bioinformatics
- The Open Bioinformatics Journal
- The Open Systems Biology Journal
- PLoS Computational Biology
- Standards in Genomics

Other Resources:

A statement regarding the adequacy of physical resources (equipment, space, etc.) must be appended. If other resources will be required to mount this course, please explain

COURSES WILL NOT BE APPROVED UNLESS IT IS CLEAR THAT ADEQUATE RESOURCES ARE AVAILABLE TO SUPPORT IT.

Lab space: Workspace will be needed to run the computer labs. Ideally, this would be a computer lab such that students without computers wouldn't be disadvantaged.

Equipment: Students will be required to work on their own laptops.

Computing: Linux and R Studio (both of which are free) hosted on YorkU server.

Lab Demonstrators: Each lab section (up to 24 Students) will require a 0.50 T2 (demonstrator) TA.

Course Rationale:

The following points should be addressed in the rationale:

How the course contributes to the learning objectives of the program / degree.

The relationship of the proposed course to other existing offerings, particularly in terms of overlap in objectives and/or content. If inter-Faculty overlap exists, some indication of consultation with the Faculty affected should be given.

The expected enrolment in the course.

The amount of biological data is growing at an alarming rate and in turn the field of bioinformatics is continuously expanding making it a highly employable field of study. Further, many fields of biology and medicine rely on bioinformatics and therefore a basic understanding of bioinformatics principles, approaches, and tools is of considerable benefit to biology researchers and medical professionals. Most Ontario universities (including Guelph, McMaster, University of Toronto, and Waterloo) offer one or more courses on bioinformatics, but currently York does not have an existing course in this area.

This course would be the first introduction for students to bioinformatics and develops students' knowledge and critical understanding of bioinformatics methods, skills, and practices.

The course maps to the following Biology program learning outcomes:

Depth and breadth of knowledge
a. Describe the basic structures and fundamental processes of life at the molecular, cellular, organismal and population levels Detailed knowledge in some specialized topics.
b. Describe some of the current advances in biology.
d. Appreciate and explore concepts and knowledge outside of science.

Knowledge of methodologies
Evaluate and carry out experimental and observational methodologies to answer questions in biology, safely and effectively.

Application of knowledge
a. Gather, organize, synthesize, and critically evaluate information from scientific literature and other sources.
b. Apply the process of science by formulating questions; developing hypotheses; designing and carrying out experiments to test hypotheses; collecting, analyzing and interpreting data to draw conclusions; and, where appropriate, propose solutions.

Communication skills
a. Speak and write effectively and clearly for a diversity of audiences.
b. Effectively communicate scientific concepts, data, and arguments through written, visual, and oral methods to peers and scientists.

Awareness of limits of knowledge
Identify limitations of biological knowledge, experiments and evidence-based inquiry, both in one's own research and that of others.

Autonomy and professional capacity
Exercise self-reflection, self-assessment and independence in learning and goal setting; take responsibility for decisions and actions.

Expected course enrolment is 96.

Faculty and Department Approval for Cross-listings:

If the course is to be cross-listed with another department, this section needs to be signed by all parties. In some cases there may be more than two signatures required (i.e. Mathematics, Women's Studies). In the majority of the cases either the Undergraduate Director or Chair of a unit approves the agreement to cross-list. All relevant signatures must be obtained prior to submission to the Faculty curriculum committee.

Dept:	Signature (Authorizing cross-listing)	Department	Date
Dept:	Signature (Authorizing cross-listing)	Department	Date
Dept:	Signature (Authorizing cross-listing)	Department	Date

Accessible format can be provided upon request.

May 30, 2023

Biol3095.3 – Introduction to Bioinformatics

Required and Recommended Reading List:

I have received the bibliography that you provided with the course description, and find that we subscribe to most of the journals in the list. I have forwarded the list to our collections department for review and to fill any gaps that we have in our subscriptions. The textbook that is not yet in our holdings has been placed on order; the other is available in the library. I recommend putting them on Reserve for short term loan.

Electronic Resources and Databases:

The primary databases and indexes of relevance include Medline PubMed, All the NCBI Databases and tools, Medline (Ovid), Biological Abstracts (Clarivate), Web of Science (Clarivate), Scopus (Elsevier), Embase (Ovid), and Ulrich's International Periodicals Directory, in addition to other specialized electronic resources listed in the Bioinformatics Research guide.
Numerous electronic books and other resources in relevant and related subject areas are found through the OMNI catalogue.

Style guides:

Council of Science Editors. Style Manual Committee. (2014). *Scientific style and format: The CSE manual for authors, editors, and publishers* (Eighth edition.). Council of Science Editors.

American Psychological Association. (2020). Publication manual of the American Psychological Association (7th ed.). Washington, DC: American Psychological Association.

Iverson, C., & American Medical Association. (2007). AMA manual of style: A guide for authors and editors (10th ed. / Cheryl Iverson (chair) ... [et al.].). Oxford; New York: Oxford University Press.

RACER: Interlibrary Loans:

The holdings in our library currently support undergraduate and graduate-level courses in related Biology, Biochemistry, Proteomics, Genomics, and Molecular Biology courses. Should there be a need for articles not available in our holdings, interlibrary loan and document delivery options are available through RACER for any additional information needs that may come up. There is no limit to the number of articles that a student or faculty member may order through RACER per year, and these are delivered to the desktop, free of charge. Books can also be requested through both the OMNI and the RACER systems free of charge. Registration and requesting is available from: http://www.library.yorku.ca/cms/resourcesharing/services-for-york-faculty-and-students/illrequestform/ .

Reserves List:

Should course instructors want to place any required readings or textbooks on reserve for student use at Steacie Library, please see the following http://www.library.yorku.ca/cms/faculty/reserves/ for information about what materials can be posted, Fair Dealing Guidelines, etc. Items to be posted can be requested by filling out the form at: http://www.library.yorku.ca/cms/faculty/reserve-request-steacie/ . Permanent links to articles we subscribe to can be created for posting in course management systems, and instructions are available here: https://researchguides.library.yorku.ca/permalinks

Library Research and Information Literacy Support:

Librarians provide research skills workshops to students and faculty on request, including but not limited to:

- Designing research strategies from asking a research question to searching the library catalogue, government sources, and databases.
- Using CSE or another citation style.
- Classes are provided on managing references using Zotero bibliographic management software. Registration is through this link: https://yorku.libcal.com/calendar/libraryworkshops?cid=7880&t=d&d=0000-00-00&cal=7880&inc=0

Research guides:

A Bioinformatics Research Guide, Biology Research Guide, Biochemistry Research Guide, and among others have been created and are maintained by subject librarians to bring together online and print resources that may be useful to students and faculty in Biology. Resources and links will be added upon request.

https://researchguides.library.yorku.ca/bioinfo
http://researchguides.library.yorku.ca/Biology
https://researchguides.library.yorku.ca/biochemistry

Collection development in the library is ongoing and is based on a commitment to developing library resources that are in alignment with the University's curricular and research activities. Books in this field will be added to the library collection as they are published. Please forward any requests for purchase to the Biology Subject Librarian: ilo@yorku.ca or submit your purchase request by using the form at https://www.library.yorku.ca/web/collections/suggestion-for-purchase-form/

In summary, I would state that we are well positioned to support this course.

Sincerely,

Ilo-Katryn Maimets, Science Librarian
102K Steacie Science and Engineering Library
E-mail: ilo@yorku.ca

FS Resource Implications Form Unit: _Biology_____ Date: _MAY 2023___

		Course Modified to		Course Modified from □
Complete Course Designation		SC/BIOL 3095 3.0 Introduction to Bioinformatics		N/A
Enrolment (Estimate)		96		N/A
Number of:	**Lecture Sections:**	1 (2 hours/week)		N/A
	Lab Sections:	4 with 24 students per section (3 hours/week)		N/A
	Tutorial Sections:	0		N/A
Number of:	**Course Coordinators (Tutor 1):**	0		N/A
	Lab Demonstrators (Tutor 2):	4		N/A
	Mark/Graders (Tutor 3):	2		N/A
Prerequisites (P) Corequisites (C) Credit Exclusions (E)		Pre-requisites: SC/BIOL 3.00 2040 *Genetics* and one of: SC/BIOL 2060 3.00 *Statistics for Biologists*, MATH2030 3.0 *Elementary Probability*, MATH 2131 3.0 *Introduction to Statistics II*.		N/A
For which degree program is this required (if applicable)?		Elective for BSc, BIOL, BCHM, BPHS, Environmental Biology Majors, Mathematical Biology and Data Science majors		N/A
Other resource implications (please specify)		Computer lab space preferred but not strictly required.		N/A
Reason(s) for creation/ modification/ retirement		New course proposal to update third year course offerings.		

Non-Major Modification Program Changes

1. Program:

   Biophysics Specialized Honours Program

2. Degree Designation: B.Sc.

3. Type of Modification: changing program core, creation of new course optional block.

4. Effective Date: Fall 2024

---

5. State what the changes are (Example: increase / decrease to the number of major credits)

   PHYS 2030 will be removed from the program core. A new “3 credits from” option block of 2000-level courses will be created. 2000-level course will be removed from existing option blocks.

6. Provide the rationale for the proposed changes that is rooted in the program learning outcomes.

   All 120 credits of Biophysics Specialized Honours degree are fully specified in the degree requirements. There are two optional blocks of courses from which students need to select “9-credits from” and “15-credit from”. These blocks contain some 2000-level course options.

   If a student were to opt for a 2000-level course included in those blocks, then their 120-credit course roster would not include the required 42 credits at the 3000/4000 level as required by the University for an Honours degree. The student would therefore be required to take more than 120 credits to complete their degree. This is not appropriate.

   The redress this issue, there are three related changes:

   A. Removal of PHYS 2030 3.0 Computation Methods for Physicists and Engineers from the Program Core.

   B. Removal of all 2000-level courses from the “9 credits from” and “15 credits from” option blocks, leaving the credits values the same.

   C. Creation of a “3-credits from” list of 2000-level courses (PHYS 2030 + 2000-level courses removed from other optional blocks).

   The degree requirements would still specify all 120 credits, however it will no longer be possible for students to select the incorrect number of 3000/4000 level credits whilst satisfying the “N-credits from” optional lists.

   There was also an incorrect total of the number of credits in the program core. It was listed as 73 credits, but it was actually 75 credits. With the removal of PHYS 2030 3.0, the Program Core will be reduced to 72 credits.

7. Provide an updated mapping of the program requirements to the program learning

outcomes to illustrate how the proposed requirements will support the achievement of program learning objectives.

8. If relevant, summarize the consultation undertaken with relevant academic units, including commentary on the impact of the proposed changes on other programs. Provide individual statements from the relevant program(s) confirming consultation and their support.

   This is purely a BPHS issue.

   Describe any resource implications and how they are being addressed (e.g., through a reallocation of existing resources). If new/additional resources are required, provide a statement from the relevant Dean(s)/Principal confirming resources will be in place to implement the changes.

   No resource implications are anticipated.

9. Provide a summary of how students currently enrolled in the program will be impacted.

   This will simplify the choosing of optional courses, removing courses which lead down a path to a greater-than-120-credit degree.

   Provide as an appendix a side-by-side comparison of the existing and proposed program requirements as they will appear in the Undergraduate or Graduate Calendar.

The program core (73 credits) is defined as: • SC/BIOL 1000 3.00 and SC/BIOL 1001 3.00; SC/BIOL 2020 3.00; SC/BIOL 2021 3.00; SC/BIOL 2040 3.00; SC/BIOL 2070 3.00; • SC/BPHS 2090 3.00; SC/BPHS 3090 3.00; SC/BPHS 4090 3.00; • SC/CHEM 1000 3.00; SC/CHEM 1001 3.00; • SC/MATH 1025 3.00; SC/MATH 2015 3.00; SC/MATH 2271 3.00; • SC/PHYS 1011 3.00 and SC/PHYS 1012 3.00; or one of SC/PHYS 1010 6.00, or SC/ISCI 1310 6.00, or SC/PHYS 1410 6.00 with a grade of C or higher, or SC/PHYS 1420 6.00 with a grade of C or higher; • SC/PHYS 2010 3.00; SC/PHYS 2020 3.00; SC/PHYS 2030 3.00; SC/PHYS 2060 3.00; SC/PHYS 2213 3.00; SC/PHYS 3030 3.00; SC/PHYS 3040 6.00; SC/PHYS 4061 3.00.	The program core (72 credits) is defined as: • SC/BIOL 1000 3.00 and SC/BIOL 1001 3.00; SC/BIOL 2020 3.00; SC/BIOL 2021 3.00; SC/BIOL 2040 3.00; SC/BIOL 2070 3.00; • SC/BPHS 2090 3.00; SC/BPHS 3090 3.00; SC/BPHS 4090 3.00; • SC/CHEM 1000 3.00; SC/CHEM 1001 3.00; • SC/MATH 1025 3.00; SC/MATH 2015 3.00; SC/MATH 2271 3.00; • SC/PHYS 1011 3.00 and SC/PHYS 1012 3.00; or one of SC/PHYS 1010 6.00, or SC/ISCI 1310 6.00, or SC/PHYS 1410 6.00 with a grade of C or higher, or SC/PHYS 1420 6.00 with a grade of C or higher; • SC/PHYS 2010 3.00; SC/PHYS 2020 3.00; SC/PHYS 2060 3.00; SC/PHYS 2213 3.00; SC/PHYS 3030 3.00; SC/PHYS 3040 6.00; SC/PHYS 4061 3.00.

A. General education:
 	
• non-science requirement: 12 credits;
• mathematics: SC/MATH 1013 3.00 and SC/MATH 1014 3.00;
• computer science: LE/EECS 1541 3.00;
• foundational science: satisfied within the major requirements.
 	
B. Major requirements:
 	
• the program core (73 credits)
 	
Additional courses:
 	
• at least nine credits from:
  ○ SC/PHYS 2040 3.00
  ○ SC/PHYS 3010 3.00
  ○ SC/PHYS 3020 3.00
  ○ SC/PHYS 3050 3.00
  ○ SC/PHYS 3090 3.00
  ○ SC/PHYS 3150 3.00
  ○ SC/PHYS 3220 3.00
  ○ SC/PHYS 3320 3.00
  ○ SC/PHYS 4010 3.00
  ○ SC/PHYS 4011 3.00
  ○ SC/PHYS 4020 3.00
  ○ SC/PHYS 4030 3.00
  ○ SC/PHYS 4040 3.00
  ○ SC/PHYS 4050 3.00
  ○ SC/PHYS 4120 3.00;
• at least 15 credits from:
  ○ HH/KINE 2031 3.00
  ○ HH/KINE 3012 3.00
  ○ HH/KINE 4455 3.00
  ○ HH/KINE 4470 3.00
  ○ SC/BIOL 2030 4.00
  ○ SC/BIOL 3010 3.00
  ○ SC/BIOL 3051 3.00
  ○ SC/BIOL 3060 4.00
  ○ SC/BIOL 3110 3.00
  ○ SC/BIOL 3120 3.00
  ○ SC/BIOL 3130 3.00
  ○ SC/BIOL 3150 4.00
	A. General education:
	
	• non-science requirement: 12 credits;
	• mathematics: SC/MATH 1013 3.00 and SC/MATH 1014 3.00;
	• computer science: LE/EECS 1541 3.00;
	• foundational science: satisfied within the major requirements.
	
	B. Major requirements:
	
	• the program core (72 credits)
	
	Additional courses:
	
	• at least three credits from:
	  ○ SC/PHYS 2030 3.00
	  ○ SC/PHYS 2040 3.00
	  ○ HH/KINE 2031 3.00
	  ○ SC/BIOL 2030 4.00
	  ○ SC/CHEM 2020 3.00
	  ○ SC/CHEM 2021 3.00
	• at least nine credits from:
	  ○ SC/PHYS 3010 3.00
	  ○ SC/PHYS 3020 3.00
	  ○ SC/PHYS 3050 3.00
	  ○ SC/PHYS 3090 3.00
	  ○ SC/PHYS 3150 3.00
	  ○ SC/PHYS 3220 3.00
	  ○ SC/PHYS 3320 3.00
	  ○ SC/PHYS 4010 3.00
	  ○ SC/PHYS 4011 3.00
	  ○ SC/PHYS 4020 3.00
	  ○ SC/PHYS 4030 3.00
	  ○ SC/PHYS 4040 3.00
	  ○ SC/PHYS 4050 3.00
	  ○ SC/PHYS 4120 3.00;
	• at least 15 credits from:
	  ○ HH/KINE 3012 3.00
	  ○ HH/KINE 4455 3.00
	  ○ HH/KINE 4470 3.00
	  ○ SC/BIOL 3010 3.00
	  ○ SC/BIOL 3051 3.00
	  ○ SC/BIOL 3060 4.00

○ SC/BIOL 3155 3.00 ○ SC/BIOL 4030 3.00 ○ SC/BIOL 4061 3.00 ○ SC/BIOL 4141 3.00 ○ SC/BIOL 4150 3.00 ○ SC/BIOL 4151 3.00 ○ SC/BIOL 4160 3.00 ○ SC/BIOL 4380 3.00 ○ SC/BPHS 4310 3.00 ○ SC/CHEM 2020 3.00 ○ SC/CHEM 2021 3.00 ○ SC/CHEM 4092 3.00 ○ SC/CHEM 4093 3.00 C. Science breadth: satisfied by above requirements. D. Upper level requirements: at least 42 credits at the 3000 or higher level, including at least 12 major credits at the 4000 level. E. Additional elective credits, as required for an overall total of at least 120 credits. F. Standing requirements: to graduate in an Honours program requires successful completion of all Faculty requirements and departmental required courses, and a minimum cumulative credit-weighted grade point average of 5.00 (C+) over all courses completed.	○ SC/BIOL 3110 3.00 ○ SC/BIOL 3120 3.00 ○ SC/BIOL 3130 3.00 ○ SC/BIOL 3150 4.00 ○ SC/BIOL 3155 3.00 ○ SC/BIOL 4030 3.00 ○ SC/BIOL 4061 3.00 ○ SC/BIOL 4141 3.00 ○ SC/BIOL 4150 3.00 ○ SC/BIOL 4151 3.00 ○ SC/BIOL 4160 3.00 ○ SC/BIOL 4380 3.00 ○ SC/BPHS 4310 3.00 ○ SC/CHEM 4092 3.00 ○ SC/CHEM 4093 3.00 C. Science breadth: satisfied by above requirements. D. Upper level requirements: at least 42 credits at the 3000 or higher level, including at least 12 major credits at the 4000 level. E. Additional elective credits, as required for an overall total of at least 120 credits. F. Standing requirements: to graduate in an Honours program requires successful completion of all Faculty requirements and departmental required courses, and a minimum cumulative credit-weighted grade point average of 5.00 (C+) over all courses completed.

May11, 2017

Changes to Existing Course

Faculty:

Department: Mathematics & Statistics

Date of Submission:

Course Number: SC/MATH 1019 3.00

Effective Session: 2023-2024

Course Title: Discrete Mathematics for Computer Science

Type of Change:

- [x] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [ ]

Change From:	To:
Prerequisites: SC/MATH 1190 3.00, or two 4U Math courses, including MHF4U (Advanced Function). Course credit exclusions: LE/EECS 1028 3.00, SC/MATH 1028 3.00, SC/MATH 2320 3.00.	Prerequisites: SC/MATH 1190 3.00 or SC/MATH 1200 3.00 or SC/MATH 2200 3.00, or two 4U Math courses, including MHF4U (Advanced Function). Course credit exclusions: LE/EECS 1028 3.00, SC/MATH 1028 3.00.

Rationale:

As many mathematics majors minor in computer science which requires SC/MATH 1019 3.00, we are adding SC/MATH 1200 3.00 and SC/MATH 2200 3.00 as prerequisite options.

SC/MATH 2320 3.00 has been removed as a course credit exclusion as it has been retired by the department.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department: Mathematics & Statistics

Date of Submission:

Course Number: SC/MATH 1021 3.00

Effective Session: 2023-2024

Course Title: Linear Algebra I

Type of Change:

- [x] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [ ]

Change From:	To:
Prerequisite: 12U Advanced Functions (MHF4U) or equivalent. Course credit exclusions: SC/MATH 1025 3.00, SC/MATH 2221 3.00, GL/MATH/MODR 2650 3.00.	Prerequisite: 12U Advanced Functions (MHF4U) or equivalent. Course credit exclusions: SC/MATH 1025 3.00, GL/MATH/MODR 1660 3.00.

Rationale:

SC/MATH 2221 3.00 is being removed as a course credit exclusion as it has been retired by the department.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department: Mathematics & Statistics

Date of Submission:

Course Number: SC/MATH 1090 3.00

Effective Session: 2023-2024

Course Title: Introduction to Logic for Computer Science

Type of Change:

- [x] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [ ]

Change From:	To:
Prerequisite: SC/MATH 1190 3.00 or SC/MATH 1019 3.00. Course credit exclusion: SC/MATH 4290 3.00.	Prerequisite: SC/MATH 1190 3.00 or SC/MATH 1019 3.00 or SC/MATH 1200 3.00 or SC/MATH 2200 3.00. Course credit exclusion: none

Rationale:

As many mathematics majors minor in computer science which requires SC/MATH 1090 3.00, we are adding SC/MATH 1200 3.00, SC/MATH 2200 3.00 as prerequisite options.

SC/MATH 4290 3.00 has been removed as a course credit exclusion as it has been retired by the department.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 1190 3.00	**Effective Session:**	2023-2024
Course Title:	Introduction to Sets and Logic		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisite: Advanced Functions (MHF4U) or equivalent, or SC/MATH 1510 6.00, or GL/MATH 1670 6.00 or SC/MATH 1710 6.00. NCR Note: This course may not be taken for degree credit by any student who has passed any 3000- or higher-level mathematics course. Course credit exclusion: GL/CSLA/MATH/MODR 1650 3.00.	Prerequisite: Advanced Functions (MHF4U) or equivalent, or SC/MATH 1510 6.00, or GL/MATH 1670 6.00. NCR Note: This course may not be taken for degree credit by any student who has passed SC/MATH 1019 3.00, SC/MATH 1200 3.00, SC/MATH 2200 3.00, or any 3000- or higher-level mathematics course. Course credit exclusion: GL/CSLA/MATH/MODR 1650 3.00.

Rationale:

SC/MATH 1710 6.00 as been removed as a possible prerequisite as it has been retired by the department.

The NCR conditions of “SC/MATH 1019 3.00, SC/MATH 1200 3.00, SC/MATH 2200 3.00” have been added to ensure students are taking the courses in the intended order and to ensure mathematics majors cannot go backwards to improve their grades by taking a course that would be trivial after taking one of these required courses.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised ‘Course Design’ and ‘Method of Instruction” information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 1300 3.00	**Effective Session:**	2023-2024
Course Title:	Differential Calculus with Applications		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisite: SC/MATH 1520 3.00 or SC/MATH 1710 6.00, or 12U Calculus and Vectors (MCV4U) or equivalent. Course credit exclusions: SC/MATH 1013 3.00, SC/MATH 1505 6.00, SC/MATH 1530 3.00, SC/MATH 1550 6.00, GL/MATH/MODR 1930 3.00, AP/ECON 1530 3.00; SC/ISCI 1401 3.00, SC/ISCI 1410 6.00.	Prerequisite: SC/MATH 1520 3.00, or 12U Calculus and Vectors (MCV4U) or equivalent. Course credit exclusions: SC/MATH 1013 3.00, SC/MATH 1505 6.00, SC/MATH 1506 3.00, SC/MATH 1507 3.00, SC/MATH 1530 3.00, SC/MATH 1550 6.00, GL/MATH/MODR 1930 3.00, AP/ECON 1530 3.00; SC/ISCI 1401 3.00, SC/ISCI 1410 6.00.

Rationale:

SC/MATH 1710 6.00 has been removed as a prerequisite as it has been retired by the department.

Since SC/MATH 1505 3.00 has been split into SC/MATH 1506 3.00 and SC/MATH 1507 3.00, these latter courses have been added as course credit exclusions. We are keeping SC/MATH 1505 3.00 as a course credit exclusion at this time as there are many students that have taken this version still enrolled at York University.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 1310 3.00	**Effective Session:**	2023-2024
Course Title:	Integral Calculus with Applications		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisite(s): One of SC/MATH 1013 3.00, SC/MATH 1300 3.00, GL/MATH 1901, SC/ISCI 1401 3.00; for non-science students only, six credits from SC/MATH 1530 3.00 and SC/MATH 1540 3.00, SC/MATH 1550 6.00, AP/ECON 1530 3.00 and AP/ECON 1540 3.00. Course credit exclusions: SC/MATH 1014 3.00, SC/MATH 1505 6.00, GL/MATH/MODR 1940 3.00, SC/ISCI 1402 3.00, SC/ISCI 1410 6.00.	Prerequisite(s): One of SC/MATH 1013 3.00, SC/MATH 1300 3.00, GL/MATH 1901, SC/ISCI 1401 3.00; for non-science students only, six credits from SC/MATH 1530 3.00 and SC/MATH 1540 3.00, SC/MATH 1550 6.00, AP/ECON 1530 3.00 and AP/ECON 1540 3.00. Course credit exclusions: SC/MATH 1014 3.00, SC/MATH 1505 6.00, SC/MATH 1506 3.00, SC/MATH 1507 3.00, GL/MATH/MODR 1940 3.00, SC/ISCI 1402 3.00, SC/ISCI 1410 6.00.

Rationale:

Since SC/MATH 1505 3.00 has been split into SC/MATH 1506 3.00 and SC/MATH 1507 3.00, these latter courses have been added as course credit exclusions. We are keeping SC/MATH 1505 3.00 as a course credit exclusion at this time as there are many students that have taken this version still enrolled at York University.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 2001 3.00	**Effective Session:**	2023-2024
Course Title:	Real Analysis I		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisites: SC/MATH 1200 3.00, SC/MATH 1310 3.00. Course credit exclusion: SC/MATH 3110 3.00, GL/MATH 3320 3.00. NCR note: MATH 2001 3.00 is not open to any student who has passed MATH 1010 3.00.	Prerequisites: SC/MATH 1200 3.00, SC/MATH 1310 3.00.

Rationale:

The course credit exclusions and the NCR note have been removed as these courses have been retired.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department: Mathematics & Statistics

Date of Submission:

Course Number: SC/MATH 2022 3.00

Effective Session: 2023-2024

Course Title: Linear Algebra II

Type of Change:

- [x] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [ ]

Change From:	To:
Prerequisite: one of SC/MATH 1021 3.00, SC/MATH 2021 3.00, GL/MATH/MODR 2650 3.00 or permission of the course coordinator. Course credit exclusions: SC/MATH 2222 3.00, GL/MATH/MODR 2660 3.00.	Prerequisite: one of SC/MATH 1021 3.00, GL/MATH/MODR 1660 3.00 or permission of the course coordinator. Corequisite: one of SC/MATH 1200 3.00 or SC/MATH 2200 3.00 or SC/MATH 1190 3.00 or SC/MATH 1019 3.00. Course credit exclusions: GL/MATH/MODR 2660 3.00.

Rationale:

SC/MATH 2021 3.00 has been removed as a prerequisite as it has been retired by the department.

SC/MATH 2222 3.00 has been removed as a course credit exclusion as it has been retired by the department.

The corequistes have been added as it has been observed over many semesters that students must be at least learning the concepts of the listed courses to be able to succeed in SC/MATH 2022 3.00. Adding these corequistes does not affect the degree progression plans for any program.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 2310 3.00	**Effective Session:**	2023-2024
Course Title:	Introduction to Calculus of Several Variables with Applications		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisite: SC/MATH 1014 3.00 or SC/MATH 1310 3.00 or SC/ISCI 1402 3.00 or SC/ISCI 1410 6.00. Students should have a knowledge of vector algebra in two and three dimensions. Course credit exclusions: SC/MATH 2015 3.00, GL/MATH/MODR 2670 3.00, GL/MATH 3200 3.00.	Prerequisite: SC/MATH 1014 3.00 or SC/MATH 1310 3.00 or SC/ISCI 1402 3.00 or SC/ISCI 1410 6.00. Students should have a knowledge of vector algebra in two and three dimensions. Course credit exclusions: SC/MATH 2015 3.00, GL/MATH/MODR 2670 3.00.

Rationale:

GL/MATH 3200 3.00 has been removed as a course credit exclusion as it has been retired.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Mathematics and Statistics	**Date of Submission:**	Fall 2021
Course Number:	MATH 3001	**Effective Session:**	FW 2022
Course Title:	Real Analysis II		

Type of Change:

[ ]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[x]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Real Analysis II	Real Analysis II – Series of Functions

Rationale:

Evidence was given to the Department of Mathematics and Statistics that having more descriptive names for our advanced pure mathematics courses could aid in attracting prospective students by showing them we offer interesting courses and be more informative to current students about what they are going to learn in a given course. The above title change reflects the material taught in MATH 3001. The prefix Real Analysis II was kept to aid students in comprehending that MATH 3001 is the second in a sequence of analysis courses and thus has Real Analysis I (MATH 2001) as a prerequisite and is a prerequisite for Real Analysis III (MATH 4011/4012).

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 3010 3.00	**Effective Session:**	2023-2024
Course Title:	Vector Integral Calculus		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisite: SC/MATH 2310 3.00; or SC/MATH 2015 3.00 and written permission of the mathematics undergraduate director (normally granted only to students proceeding in Honours programs in mathematics or in the Specialized Honours program in statistics). Prerequisite or corequisite: SC/MATH 2022 3.00 or SC/MATH 2222 3.00.	Prerequisite: SC/MATH 2310 3.00 or SC/MATH 2015 3.00. Prerequisite or corequisite: SC/MATH 2022 3.00.

Rationale:

SC/MATH 2222 3.00 has been removed as a course credit exclusion as it has been retired by the department.

The prerequisite change was made to enable more students that are not mathematics majors to be able to enroll in this course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 3021 3.00	**Effective Session:**	2023-2024
Course Title:	Algebra I – Group Theory		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisites: SC/MATH 1019 3.00 or SC/MATH 1190 3.00 or SC/MATH 1200 3.00; SC/MATH 2022 3.00 or SC/MATH 2222 3.00. Course credit exclusions: SC/MATH 3020 6.00, GL/MATH 3650 6.00, GL/MODR 3650 6.00, GL/MATH 3510 3.00.	Prerequisites: SC/MATH 1019 3.00 or SC/MATH 1190 3.00 or SC/MATH 1200 3.00 or SC/MATH 2200 3.00; SC/MATH 2022 3.00. Course credit exclusions: GL/MATH 3650 6.00, GL/MODR 3650 6.00, GL/MATH 3510 3.00.

Rationale:

SC/MATH 2200 3.00 was added as a prerequisite as SC/MATH 1200 3.00 and SC/MATH 2200 3.00 are course credit exclusions and often the latter must be taken by transfer students.

SC/MATH 2222 3.00 has been removed as a prerequisite as it has been retired by the department.

SC/MATH 3020 6.00 has been removed as a course credit exclusion as it has been retired by the department.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Mathematics and Statistics	**Date of Submission:**	Fall 2021
Course Number:	MATH 3021	**Effective Session:**	FW 2022
Course Title:	Algebra I		

Type of Change:

[ ]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[x]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Algebra I	Algebra I – Group Theory

Rationale:

Evidence was given to the Department of Mathematics and Statistics that having more descriptive names for our advanced pure mathematics courses could aid in attracting prospective students by showing them we offer interesting courses and be more informative to current students about what they are going to learn in a given course. The above title change reflects the material taught in MATH 3021. The prefix Algebra I was kept to aid students in comprehending that MATH 3021 is the first in a sequence of algebra courses and thus a prerequisite for Algebra II (MATH 3022).

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department: Mathematics & Statistics

Date of Submission:

Course Number: SC/MATH 3022 3.00

Effective Session: 2023-2024

Course Title: Algebra II – Rings and Fields

Type of Change:

- [x] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [ ]

Change From:	**To:**
Prerequisites: SC/MATH 3021 3.00 or permission of the course coordinator. Course credit exclusions: SC/MATH 3020 6.00, GL/MATH 3650 6.00, GL/MODR 3650 6.00, GL/MATH 3515 3.00.	Prerequisites: SC/MATH 3021 3.00. Course credit exclusions: GL/MATH 3650 6.00, GL/MODR 3650 6.00, GL/MATH 3515 3.00.

Rationale:

SC/MATH 3020 6.00 has been removed as a course credit exclusion as it has been retired by the department.

The “permission of the course coordinator” portion of the prerequistes has been removed as it is redundant.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised ‘Course Design’ and ‘Method of Instruction” information.

Changes to Existing Course

Faculty: Science

Department:	Mathematics and Statistics	**Date of Submission:**	Fall 2021
Course Number:	MATH 3022	**Effective Session:**	FW 2022
Course Title:	Algebra II		

Type of Change:

☐	in pre-requisite(s)/co-requisite(s)	☐	in cross-listing
☐	in course number/level	☐	in degree credit exclusion(s)
☐	in credit value	☐	regularize course (from Special Topics)
☒	in title (max. 40 characters for short title)	☐	in course format/mode of delivery *
☐	in Calendar description (max. 40 words or 200 characters)	☐	retire/expire course
☐	other (please specify):	☐	

Change From:	**To:**
Algebra II	Algebra II – Rings and Fields

Rationale:

Evidence was given to the Department of Mathematics and Statistics that having more descriptive names for our advanced pure mathematics courses could aid in attracting prospective students by showing them we offer interesting courses and be more informative to current students about what they are going to learn in a given course. The above title change reflects the material taught in MATH 3022. The prefix Algebra II was kept to aid students in comprehending that MATH 3022 is the second in a sequence of algebra courses and thus has Algebra I (MATH 3021) as a prerequiste and is a prerequisite for Algebra III (MATH 4021).

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 3410 3.00	**Effective Session:**	2023-2024
Course Title:	Complex Variables		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisite: SC/MATH 2010 3.00 or SC/MATH 2015 3.00 or SC/MATH 2310 3.00. (SC/MATH 3010 3.00 is also recommended as a prerequisite for students who have taken SC/MATH 2010 3.00.) Course credit exclusion: GL/MATH 4230 3.00.	Prerequisite: SC/MATH 2015 3.00 or SC/MATH 2310 3.00. (SC/MATH 2001 3.00 is also recommended as a prerequisite especially for students who have not taken SC/MATH 2310 3.00.) Course credit exclusion: GL/MATH 4230 3.00.

Rationale:

SC/MATH 2010 3.00 has been removed as a prerequisite as it has been retired by the department.

The recommended prerequisite has been updated based on instructor recommendations for what students should expect to need to know to be prepared for this course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 4011 3.00	**Effective Session:**	2023-2024
Course Title:	Real Analysis IIIA – Metric Spaces		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisites: SC/MATH 3001 3.00, SC/MATH 2022 3.00.	Prerequisites: SC/MATH 3001 3.00, SC/MATH 2022 3.00. Course Credit Exclusions: GL/MATH 4240 6.00.

Rationale:

GL/MATH 4240 6.00 was added as a course credit exclusion due to the overlap between these courses. SC/MATH 4011 3.00 is already a course credit exclusion for GL/MATH 4240 6.00.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Mathematics and Statistics	**Date of Submission:**	Fall 2021
Course Number:	MATH 4011	**Effective Session:**	FW 2022
Course Title:	Metric Spaces		

Type of Change:

[ ]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[x]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Metric Spaces	Real Analysis IIIA – Metric Spaces

Rationale:

Evidence was given to the Department of Mathematics and Statistics that having more descriptive names for our advanced pure mathematics courses could aid in attracting prospective students by showing them we offer interesting courses and be more informative to current students about what they are going to learn in a given course. The above title change reflects the material taught in MATH 4011. The prefix Real Analysis IIIA was added to aid students in comprehending that MATH 4011 is one of two options for the third in a sequence of analysis courses (the other being MATH 4012 – Real Analysis IIIB) and has Real Analysis II (MATH 3001) as a prerequiste.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 4012 3.00	**Effective Session:**	2023-2024
Course Title:	Real Analysis IIIB – Lebesgue Measure Theory		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisites: SC/MATH 3001 3.00.	Prerequisites: SC/MATH 3001 3.00. Course Credit Exclusions: GL/MATH 4240 6.00.

Rationale:

GL/MATH 4240 6.00 was added as a course credit exclusion due to the overlap between these courses. SC/MATH 4012 3.00 is already a course credit exclusion for GL/MATH 4240 6.00.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Mathematics and Statistics	**Date of Submission:**	Fall 2021
Course Number:	MATH 4012	**Effective Session:**	FW 2022
Course Title:	Lebesgue Measure Theory		

Type of Change:

[ ]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[x]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Lebesgue Measure Theory	Real Analysis IIIB – Lebesgue Measure

Rationale:

Evidence was given to the Department of Mathematics and Statistics that having more descriptive names for our advanced pure mathematics courses could aid in attracting prospective students by showing them we offer interesting courses and be more informative to current students about what they are going to learn in a given course. The prefix Real Analysis IIIB was added to aid students in comprehending that MATH 4012 is one of two options for the third in a sequence of analysis courses (the other being MATH 4011 – Real Analysis IIIA) and has Real Analysis II (MATH 3001) as a prerequiste. The word "Theory" was dropped due to character length and as it was redundant.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 4021 3.00	**Effective Session:**	2023-2024
Course Title:	Algebra III – Advanced Group Theory		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisite: SC/MATH 3020 6.00 or SC/MATH 3022 3.00 or permission of the course coordinator. Course credit exclusions: SC/MATH 4020 6.00, SC/MATH 4241 3.00.	Prerequisite: SC/MATH 3022 3.00.

Rationale:

The above changes were made as the removed courses have been retired by the department.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Mathematics and Statistics	**Date of Submission:**	Fall 2021
Course Number:	MATH 4021	**Effective Session:**	FW 2022
Course Title:	Algebra III		

Type of Change:

☐	in pre-requisite(s)/co-requisite(s)	☐	in cross-listing
☐	in course number/level	☐	in degree credit exclusion(s)
☐	in credit value	☐	regularize course (from Special Topics)
☒	in title (max. 40 characters for short title)	☐	in course format/mode of delivery *
☐	in Calendar description (max. 40 words or 200 characters)	☐	retire/expire course
☐	other (please specify):	☐	

Change From:	**To:**
Algebra III	Algebra III – Advanced Group Theory

Rationale:

Evidence was given to the Department of Mathematics and Statistics that having more descriptive names for our advanced pure mathematics courses could aid in attracting prospective students by showing them we offer interesting courses and be more informative to current students about what they are going to learn in a given course. The above title change reflects the material taught in MATH 4021. The prefix Algebra III was kept to aid students in comprehending that MATH 4021 is the third in a sequence of algebra courses and thus has Algebra II (MATH 3022) as a prerequiste and is a prerequisite for Algebra IV (MATH 4022).

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Mathematics and Statistics	**Date of Submission:**	Fall 2021
Course Number:	MATH 4022	**Effective Session:**	FW 2022
Course Title:	Algebra IV		

Type of Change:

☐	in pre-requisite(s)/co-requisite(s)	☐	in cross-listing
☐	in course number/level	☐	in degree credit exclusion(s)
☐	in credit value	☐	regularize course (from Special Topics)
☒	in title (max. 40 characters for short title)	☐	in course format/mode of delivery *
☐	in Calendar description (max. 40 words or 200 characters)	☐	retire/expire course
☐	other (please specify):	☐	

Change From:	**To:**
Algebra IV	Algebra IV – Topics in Applied Algebra

Rationale:

Evidence was given to the Department of Mathematics and Statistics that having more descriptive names for our advanced pure mathematics courses could aid in attracting prospective students by showing them we offer interesting courses and be more informative to current students about what they are going to learn in a given course. The above title change reflects the material taught in MATH 4022. The prefix Algebra IV was kept to aid students in comprehending that MATH 4022 is the fourth in a sequence of algebra courses and thus has Algebra III (MATH 4021) as a prerequiste.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 4081 3.00	**Effective Session:**	2023-2024
Course Title:	Topology I		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisites: SC/MATH 3210 3.00 or SC/MATH 3001 3.00 or permission of the course coordinator.	Prerequisites: SC/MATH 3001 3.00.

Rationale:

SC/MATH 3210 3.00 has been removed as a possible prerequisite as it has been retired by the department.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty:

Department:	Mathematics & Statistics	**Date of Submission:**	
Course Number:	SC/MATH 4160 3.00	**Effective Session:**	2023-2024
Course Title:	Combinatorial Mathematics		

Type of Change:

[x]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Prerequisites: SC/MATH 2022 3.00 or SC/MATH 2222 3.00; six credits from 3000-level mathematics courses without second digit 5; or permission of the course coordinator.	Prerequisites: SC/MATH 2022 3.00; six credits from 3000-level mathematics courses without second digit 5.

Rationale:

SC/MATH 2222 3.00 has been removed as a possible prerequisite as it has been retired by the department.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Natural Sciences	**Date of Submission:**	June 14 2023
Course Number:	NATS 1515.03	**Effective Session:**	FW 2024-25
Course Title:	Atmospheric Pollution		

Type of Change:

[X]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description	[ ]	retire/expire course
[X]	other (please specify): **NCR**		

Change From:	**To:**
COURSE DESCRIPTION: Everyday human activities, such as driving vehicles, cooking food and using electricity, can all be important sources of pollution to Earth's atmosphere. During this course, students explore the major contributors to atmospheric pollution globally, explain their source and transport through the Earth's systems, and examine their impact on human and environmental health. Modern day local pollution phenomena, such as smog and acid rain, as well as global-scale concerns, such as the Antarctic Ozone Hole and climate change, are explored in detail. New government policies and green technologies that are used to minimize the damaging effects of atmospheric pollution are discussed. Pre-requisite: NATS 1512 3.00. Course Credit Exclusions: SC/NATS 1840 6.00, SC/NATS 1750 6.00. No credit will be retained for any student who has passed or is taking SC/CHEM 1000 3.00 or SC/CHEM 1001 3.00. Not open to any students enrolled in a Chemistry program.	COURSE DESCRIPTION: Everyday human activities, such as driving vehicles, cooking food and using electricity, can all be important sources of pollution to Earth's atmosphere. During this course, students explore the major contributors to atmospheric pollution globally, explain their source and transport through the Earth's systems, and examine their impact on human and environmental health. Modern day local pollution phenomena, such as smog and acid rain, as well as global-scale concerns, such as the Antarctic Ozone Hole and climate change, are explored in detail. New government policies and green technologies that are used to minimize the damaging effects of atmospheric pollution are discussed. ~~Pre-requisite: NATS 1512 3.00.~~ Course Credit Exclusions: SC/NATS 1840 6.00, SC/NATS 1750 6.00. ~~No credit will be retained for any student who has passed or is taking SC/CHEM 1000 3.00 or SC/CHEM 1001 3.00. Not open to any students enrolled in a Chemistry program.~~ **No credit will be retained for any student who has passed or is taking SC/CHEM 3060 3.00 or SC/CHEM 3061 3.00.**

Rationale:	In FW23-24, NATS piloted the use of pre-reqs in 3 courses: NATS1665 Plants in the City, NATS1515 Atmospheric Pollution and NATS1516 Water Pollution. The instructors for these courses have since agreed that the logistical challenges of enforcing the pre-reqs outweigh their pedagogical value.

The logistical challenge of requiring pre-reqs for a NATS course is, not only are pre-reqs not enforced by the online enrolment system, they are also not checked when a student applies for graduation. In contrast, when pre-reqs are part of a student's major, a missing pre-req is caught during the graduation process. Thus, the only way for NATS to enforce a pre-req is to continually monitor the class list every day until the enrolment window closes and remove students who lack the pre-req, a task for which NATS does not have sufficient staff resources given our large class sizes. It was our expectation that this task wouldn't be necessary as we anticipated students would avoid a course for which they lacked the pre-req. Unfortunately, when we checked the class lists for NATS1515 and NATS1516 within a few weeks of the course start date, we learned that over 100 students lacked the pre-req, despite explicit text in the course description, course outline, and frequent reminders during lectures. Even more concerning, this meant that only ~5% of eligible students enrolled in these courses, meaning that the courses would have likely been cancelled had the pre-reqs been enforced.

As stated in the original course proposals for NATS1515 and NATS1516, the NATS1512 pre-req ensures students will "…be familiar with taking a science course and the scientific process.". However, upon learning that only a handful of students possessed the pre-reqs, the course director proceeded with the course with this in mind and determined that a review of the pre-requisite scientific fundamentals could be incorporated into the course without significantly cutting down on the planned material. In addition, the course instructer has decided to offer online review modules for W24 to enable students to obtain the required background without having taken the pre-req. Thus, the pre-req for this course should be dropped because (1) it cannot be enforced and (2) the pre-req material can be incorporated into the course without affecting the course's original learning objectives.

In regard to the change in NCR, the course director has determined that the existing restrictions on Chemistry students are unnecessarily limiting, owing to the course's specialized material and the fact that chemistry fundamentals comprise a small fraction of the course material. Instead, the NCR has been limited to the Chemistry electives CHEM3060: Introduction to Atmospheric Chemistry (for NATS1515) and/or CHEM3061: Environmental Chemistry (for NATS1515 and NATS1516). Either of these CHEM courses would give a student a significant academic advantage if they were taken prior to NATS1515 or NATS1516.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Natural Sciences	**Date of Submission:**	June 14 2023
Course Number:	NATS 1516.03	**Effective Session:**	FW 2024-25
Course Title:	Water Pollution		

Type of Change:

[X]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description	[ ]	retire/expire course
[X]	other (please specify): **NCR**		

Change From:	**To:**
COURSE DESCRIPTION: Although water is a necessity for human life, there are many populations in the world who do not have access to a clean water source. Human activities, such as washing clothing, applying fertilizer to agricultural crops, and operating power plants can all be important sources of pollution to Earth's aquatic systems. During this course, students explore the major contributors to water pollution globally (e.g. pesticide pollution, thermal pollution), explain their source and transport through the Earth's systems and examine their impact on aquatic ecosystems. Students also investigate the control of water pollution as well as the treatment of waste water prior to human consumption. New government policies and technologies that can be used to minimize the damaging effects of water pollution will be discussed. Prerequisites: NATS1512: Environmental Pollution. NCR: No credit will be retained for any student who has passed or is taking SC/CHEM 1000 3.00 or SC/CHEM 1001 3.00. Not open to any students enrolled in a Chemistry program.	COURSE DESCRIPTION: Although water is a necessity for human life, there are many populations in the world who do not have access to a clean water source. Human activities, such as washing clothing, applying fertilizer to agricultural crops, and operating power plants can all be important sources of pollution to Earth's aquatic systems. During this course, students explore the major contributors to water pollution globally (e.g. pesticide pollution, thermal pollution), explain their source and transport through the Earth's systems and examine their impact on aquatic ecosystems. Students also investigate the control of water pollution as well as the treatment of waste water prior to human consumption. New government policies and technologies that can be used to minimize the damaging effects of water pollution will be discussed. ~~Pre-requisite: NATS 1512: : Environmental Pollution. NCR: No credit will be retained for any student who has passed or is taking SC/CHEM 1000 3.00 or SC/CHEM 1001 3.00. Not open to any students enrolled in a Chemistry program.~~ **NCR: No credit will be retained for any student who has passed or is taking SC/CHEM 3061 3.00.**

Rationale: See rationale for NATS1515.03 course change, dated June 14 2023.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

Changes to Existing Course

Faculty: Science

Department:	Natural Sciences	**Date of Submission:**	June 14 2023
Course Number:	NATS 1512.03	**Effective Session:**	FW 2024-25
Course Title:	Environmental Pollution		

Type of Change:

[X]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description	[ ]	retire/expire course
[X]	other (please specify): **NCR**		

Change From:	**To:**
COURSE DESCRIPTION: Human activities, such as washing clothes, driving vehicles, cooking food and using electricity, can be important contributors to pollution on and around the planet Earth. During this course students examine important areas of pollution with a focus on Air Pollution, Water Pollution and Soil/Land Pollution. Students are introduced to many sources of pollution, transport and fate of common pollutants as well as modern-day pollution phenomena, such as urban smog. New government policies and remediation techniques that can be used to minimize the damaging effects of pollution will be discussed. This course is a pre-requisite for NATS1515: Atmospheric Pollution and NATS1516: Water Pollution. Prerequisites: None. Co-requisites: None. NCR: No credit will be retained for any student who has passed or is taking SC/CHEM 1000 3.00 or SC/CHEM 1001 3.00. Not open to any students enrolled in a Chemistry program.	COURSE DESCRIPTION: Human activities, such as washing clothes, driving vehicles, cooking food and using electricity, can be important contributors to pollution on and around planet Earth. During this course students examine important areas of pollution with a focus on Air Pollution, Water Pollution and Soil/Land Pollution. Students are introduced to many sources of pollution, transport, and fate of common pollutants as well as modern-day pollution phenomena, such as urban smog. New government policies and remediation techniques that can be used to minimize the damaging effects of pollution will be discussed. ~~This course is a pre-requisite for NATS1515: Atmospheric Pollution and NATS1516: Water Pollution.~~ Prerequisites: None. Co-requisites: None. ~~NCR: No credit will be retained for any student who has passed or is taking SC/CHEM 1000 3.00 or SC/CHEM 1001 3.00. Not open to any students enrolled in a Chemistry program.~~**NCR: No credit will be retained for any student who has passed or is taking SC/CHEM 3060 3.00 or SC/CHEM 3061 3.00.**

Rationale:

Removal of pre-req statement: See rationale for NATS1515.03 course change, dated June 14 2023.

NCR change: the course director has determined that the existing restrictions on Chemistry students are unnecessarily limiting, given that chemistry fundamentals comprise a small fraction of the course material. Instead, the NCR has been limited to the Chemistry electives CHEM3060:

Introduction to Atmospheric Chemistry and/or CHEM3061: Environmental Chemistry. Either of these CHEM courses would give a student a significant academic advantage if they were taken prior to NATS1512.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Natural Sciences	**Date of Submission:**	June 14 2023
Course Number:	NATS 1665.03	**Effective Session:**	FW 2024-25
Course Title:	Plants in the City		

Type of Change:

- [X] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description (max. 40 words or 200 characters)
- [ ] other (please specify):
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course

Change From:	**To:**
COURSE DESCRIPTION: Plants surround us every day, providing a green backdrop to our daily lives, but they are providing more than a pretty landscape. This course highlights important ecosystems throughout the Greater Toronto Area, and identifies the major plant groups that define them. This course provides a foundation in hands-on plant identification skills through field, laboratory, and independent activities and explores some traditional and modern uses of native and introduced plants. We apply principles of ecology, conservation, and global change in the context of urban and suburban ecosystems, and learn how to be more environmentally responsible and engaged citizens. Note: students enrolling in this course should expect to spend a significant amount of time outdoors in both group and independent settings. Pre-requisites: SC/NATS 1565 3.00 or SC/NATS 1940 6.00	COURSE DESCRIPTION: Plants surround us every day, providing a green backdrop to our daily lives, but they are providing more than a pretty landscape. This course highlights important ecosystems throughout the Greater Toronto Area, and identifies the major plant groups that define them. This course provides a foundation in hands-on plant identification skills through field, laboratory, and independent activities and explores some traditional and modern uses of native and introduced plants. We apply principles of ecology, conservation, and global change in the context of urban and suburban ecosystems, and learn how to be more environmentally responsible and engaged citizens. Note: students enrolling in this course should expect to spend a significant amount of time outdoors in both group and independent settings~~. Pre-requisites: SC/NATS 1565 3.00 or SC/NATS 1940 6.00~~

Rationale: In FW23-24, NATS piloted the use of pre-reqs in 3 courses: NATS1665 Plants in the City, NATS1515 Atmospheric Pollution and NATS1516 Water Pollution. The instructors for these courses have since agreed that the logistical challenges of enforcing the pre-reqs outweigh their pedagogical value.

The logistical challenge of requiring pre-reqs for a NATS course is, not only are pre-reqs not enforced by the online enrolment system, they are also not checked when a student applies for graduation. In contrast, when pre-reqs are part of a student's major, a missing pre-req is caught during the graduation process. Thus, the only way for NATS to enforce a pre-req is to continually monitor the class list every day until the enrolment window closes and remove students who lack the pre-req, a task for which NATS does not have sufficient staff resources given our large class sizes. It was our expectation that this task wouldn't be necessary as we anticipated students would avoid a course for which they lacked the pre-req. Unfortunately, when we checked the class lists for NATS1515 and NATS1516 within a few weeks of the course start date, we learned that over 100 students lacked the pre-req, despite explicit text in the course description, course outline, and frequent reminders during lectures. Even more concerning, this meant that only ~5% of eligible students enrolled in these courses, meaning that the courses would have likely been cancelled had the pre-reqs been enforced.

In the case of NATS1665, offered for the first time in SU23, the enrolment was far lower than expected, partially due to a delay in the course being added to the list of General Education courses on the York Courses website. (We reported this to the OUR several months before the start of the SU23 enrolment window but unfortunately it could not be resolved until late April). By mid-April, only 9 students enrolled in NATS1665 (with a max enrolment of 48), only 3 of which possessed the pre-req. This suggests that even if the enrolment in NATS1665 increases in SU24 (as we expect to occur), we'll have a similar logistical challenge as with NATS1515 and NATS1516, in that most students will enrol without the pre-req. It should also be noted that one of the pre-reqs, NATS1940, is a 6-credit course, making it unlikely that students with this pre-req will enrol in NATS1665 as they will have already completed their 6-credit requirement in NATS.

As stated in the original course proposal for NATS1665, "The pre-requisites (NATS 1565 or NATS 1940) provide students the foundations in plant biology and ecosystems required to execute a laboratory/field based course in this area of science." In addition to the knowledge gained from either of these courses, it was felt that success in a field course required a degree of academic maturity and should therefore be restricted to students beyond their 1st year. However, as NATS1665 was in danger of being cancelled for SU23, the course director consented to waiving the pre-reqs. We therefore sent out an email to all NATS students indicating that the pre-req would be waived for the course's first offering in the SU23 term. This attracted another 9 students. With only 3 of 18 students possessing the pre-req, the course director has determined that the knowledge requirement is not necessary for students to achieve the course's learning objectives. Moreover, the pre-req is not necessary in order to prevent 1st-year students from enrolling, as the course can only be offered in the summer term owing to its outdoor component.

In conclusion, the pre-reqs for this course should be dropped because (1) they cannot be enforced and (2) they are not required for students to achieve the course's learning objectives and to be successful in the course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Natural Sciences	**Date of Submission:**	June 10 2023
Course Number:	NATS 1870.06	**Effective Session:**	FW 2024-25
Course Title:	Understanding Colour		

Type of Change:

☐	in pre-requisite(s)/co-requisite(s)	☐	in cross-listing
☐	in course number/level	☐	in degree credit exclusion(s)
☐	in credit value	☐	regularize course (from Special Topics)
☐	in title (max. 40 characters for short title)	X	in course format/mode of delivery *
☐	in Calendar description (max. 40 words or 200 characters)	☐	retire/expire course
☐	other (please specify):	☐	

Change From:	**To:**
LECT, ONLN, ONCA	LECT, ONLN, ONCA, **BLEN**

Rationale:

The current LECT format for NATS 1870A consists of 3 hour lectures, with a formal lecture component, videos, quizzes (done both in-class and at home) at-home readings, at-home hands-on 'kitchen science' experiments and assignments, and exams on campus. In the classroom, interactive/active learning activities do occur, but we would like to enhance the experiential component of the course and deepen student engagement with the course material.

One of the difficulties with the standard 3-hour lecture format is that some students take notes passively. It is harder for this type of learner to engage in classroom active-learning activities because they have not had sufficient time to think about the material, which can be conceptually new and often challenging to non-science students. In a flipped format, students will be able to access lectures at their own speed (they can stop, start, and repeat more complex material), as well as have more time to learn and reflect on the material. Students will be quizzed on the online material before the in-class session, to ensure they come to the in-class session better prepared to engage in the active-learning component.

The flipped format will provide the benefits of online, asynchronous learning (going at your own pace, according to your own timetable) with in-class experiences aimed at deepening learning and fostering critical thinking skills, while being guided by the instructor. Farmus et al. (2020) found that the flipped classroom model allowed for time spent with the instructor to focus on deeper learning and application; increased cooperative learning and classroom innovation and allowed students to learn from each other and develop their communication skills. Travis et al. (2016) found that with more before-class preparation, students felt that they 'obtained a deeper understanding of the problems with which they were tasked'. Shinaberger (2017) found that flipped classrooms benefit students significantly, with increased exam scores, and increased student satisfaction.

SOURCES:

Linda Farmus, Robert A. Cribbie & Michael A. Rotondi (2020) The Flipped Classroom in Introductory Statistics: Early Evidence From a Systematic Review and Meta-Analysis, Journal of Statistics Education, 28:3, 316-325, DOI: 10.1080/10691898.2020.1834475

Travis M. Loux, Sara Emily Varner & Matthew VanNatta (2016) Flipping an Introductory Biostatistics Course: A Case Study of Student Attitudes and Confidence, Journal of Statistics Education, 24:1, 1-7, DOI: 10.1080/10691898.2016.1158017

Lee Shinaberger (2017) Components of a Flipped Classroom Influencing Student Success in an Undergraduate Business Statistics Course, Journal of Statistics Education, 25:3, 122-130, DOI: 10.1080/10691898.2017.1381056

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Course Design:

Indicate how the course design supports students in achieving the learning objectives. For example, in the absence of scheduled contact hours what role does student-to-student and/or student-to-instructor communication play, and how is it encouraged?

Detail any aspects of the content, delivery, or learning goals that involve "face-to-face" communication, non-campus attendance or experiential education components.

Alternatively, explain how the course design encourages student engagement and supports student learning in the absence of substantial on-campus attendance.

The course will consist of a flipped format, with online materials (including lectures, videos and readings) being accessed asynchronously, followed by an online quiz, then in-class sessions with focused discussions and guided interactive/active learning activities.

The asynchronous online materials will be posted weekly on eClass. Following the online activities, quizzes on the material will be due before the in-class session. Students will arrive at the face-to-face sessions better prepared to discuss and engage with the materials.

The in-class sessions will have varied formats, depending on the specific topic/material. In-class sessions will typically be a mix of short (10-15min) lectures and active learning activities. Active learning activities will include worksheets, which will be handed in (to ensure attendance as well as students' active participation in the course); discussions in small groups, with summaries/reflections handed in at the end of the class; and other interactive activities. Students will also have the opportunity to do some of the 'kitchen science' activities at home and then bring their results to class for further discussion and to share their experiences with fellow students (e.g. fabrics dyed with natural dyes).

On-campus exams will remain the same.

Instruction:

1. Planned frequency of offering and number of sections anticipated (every year, alternate years, etc.).
2. Number of department members currently competent to teach the course.
3. Instructor(s) likely to teach the course in the coming year.
4. An indication of the number of contact hours (defined in terms of hours, weeks, etc.) involved, in order to indicate whether an effective length of term is being maintained **OR** in the absence of scheduled contact hours a detailed breakdown of the estimated time students are likely to spend engaged in learning activities required by the course.

1. No change

2. Robin Kingsburgh, Banafsheh Hashemi Pour, Mary Helen Armour, Tatiana Ouvarova

3. Robin Kingsburgh, Tatiana Ouvarova

4. The current LECT version of NATS 1870 has:
- 3h lecture x 24 weeks = 72 hours

The BLEN format will have
- 1.5h online component x 24 weeks = 36 hours
- 1.5h face-to-face class x 24 weeks = 36 hours
- Total = 72 hours

Changes to Existing Course

Faculty: SC

Department:	NATS/STS	**Date of Submission:**	30-May-2023
Course Number:	NATS1920A	**Effective Session:**	FW24-25
Course Title:	THE NATURE AND GROWTH OF IDEAS IN MATHEMATICS		

Type of Change:

[ ]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[X]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[X]	in Calendar description	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
TITLE: The Nature and Growth of Ideas in Mathematics CALENDAR DESCRIPTION: Students are shown the central position of mathematics in our culture: great discoveries in mathematics and their effect on general culture and society; history of mathematics; mathematics of art and architecture, sound, games and gambling and computing.	TITLE: The Evolution of Mathematical Genius CALENDAR DESCRIPTION: Like great pieces of art and literature, mathematical theorems have revolutionized the world. This course introduces students to history's most transformative mathematical theorems. Each theorem is explored in its historical context with a focus on the mathematics and the mathematician. Students will learn of the greatest mathematicians of all time, their often quirky or contentious personalities, and their turbulent lives. Mathematical topics may include Egyptian Numerals, Base 60, Geometry, Algebra, Sequences and Series, Number Theory and Probability. No particular background in mathematics is required. This course is accessible to anyone with a desire to learn, and students will gain knowledge of the basics of mathematics as well as quantitative problem-solving skills.

Rationale:

For a number of years, this course was taught by a full-time faculty member in the MATH department. In 2020, NATS hired a full-time faculty member specializing in math eduction for non-science majors. This faculty member has overhauled the course to include updated material and assessments, with the goal of making the course more attractive to non-science majors who would benefit from improving their quantitative problem solving skills. The revised course description and course title are more compelling and more accurately reflect what students will gain from the course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: Science

Department:	Physics and Astronomy	**Date of Submission:**	Spring 2023
Course Number:	SC/PHYS 1800 3.0	**Effective Session:**	Fall 2024
Course Title:	Engineering Mechanics		

Type of Change:

☐	in pre-requisite(s)/co-requisite(s)	☐	in cross-listing
☐	in course number/level	☐	in degree credit exclusion(s)
☐	in credit value	☐	regularize course (from Special Topics)
☐	in title (max. 40 characters for short title)	X	in course format/mode of delivery *
☐	in Calendar description (max. 40 words or 200 characters)	☐	retire/expire course
☐	other (please specify):	☐	

Change From:	**To:**
Mode of Delivery: LECT	Mode of Delivery: LECT or BLEN (BLEN only if offered in block-format)

Rationale:

Lassonde is piloting a novel scheduling format where first-year engineering students complete their fall courses in series rather than parallel. So-called Block Format. PHYS 1800 will run in a 3-week block.
In addition to the accelerated presentation of material, the Lassonde design calls for a blended presentation. In-person lectures, tutorials and labs will take place on Tuesdays and Thursdays. Remote asynchronous lectures, tutorials and labs will take place on Mondays and Wednesdays. This describes a BLEN format.

Special decanal permission was granted for the Fall 2023 offering in BLEN format, but if this block-format offering persists in future years (pending review of the pilot) this official curricular change is required.

It is not the intention at this point to offer normally paced PHYS 1800 in anything other than LECT format.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

COMMITTEE ON ACADEMIC STANDARDS, CURRICULUM AND PEDAGOGY TEMPLATE

NEW COURSE PROPOSAL FORM

Faculty: Indicate all relevant Faculty(ies)	Science

Department: Indicate department and course prefix (e.g. Languages, GER)	Physics and Astronomy (PHYS)	**Date of Submission:**	TBA

Course Number: Special Topics courses Include variance (e.g. HUMA 3000C 6.0, Variance is "C")	3130	**Var:**	**Academic Credit Weight:** Indicate both the fee, and MTCU weight if different from academic weight (e.g. AC=6, FEE=8, MET=6	3.0

Course Title: The official name of the course as it will appear in the Undergraduate Calendar and on the Repository	Practical Data Science Methods in Physical Sciences
Short Title: Appears on any documents where space is limited - e.g. transcripts and lecture schedules - **maximum 40 characters**	Practical Data Science Methods

With every new course proposal it is the Department's responsibility to ensure that new courses do not overlap with existing courses in other units. If similarities exist, consultation with the respective departments is necessary to determine degree credit exclusions and/or cross-listed courses.

Brief Course Description:

Maximum 2000 characters
(approximately 300 words including spaces and punctuation).

The course description should be carefully written to convey what the course is about. It should be followed by a statement of prerequisites and co-requisites, if applicable. This description appears in the calendar.

For editorial consistency, and in consideration of the various uses of the Calendars, verbs should be in the present tense (i.e., "This course analyzes the nature and extent of...," rather than "This course will analyze...")

This course provides practical modern research methods including a wide range of skills encompassing statistics, research methodologies and data science investigations. This course allows students to conduct their own research project, conduct a literature review, use, and understand physics and astronomy data science methods, access cloud computing tools, and employ Python code to illustrate their research methods. Real physics and astronomy data sets are required (students may choose from provided sets or select a new one with instructor approval) for all student projects. Through the research project, students employ critical thinking to solve a problem on real-world data. Students enhance their written communication as well as knowledge of the data science environment by presenting their project at the end of the course. The tool-centric nature of this course will see students introduced to many modern scientific workhorses like the API (Application Program Interface) call, pipelines, databases, SQL, TopCat and more. This course provides not only an invaluable toolkit to students, but also a roadmap on how to use these tools and techniques in science research. Students may find this course a helpful precursor to research and 4000 level courses like PHYS 4030, 4270, 4310 and more.

Prerequisites: SC/PHYS 2213 3.0, SC/PHYS 2030 3.0, or permission of the instructor.

Generic Course Description:

This is the description of the "Parent / Generic course" for Special Topics courses under which variances of the "Generic" course can be offered in different years (Max. 40 words). Generic course descriptions are published in the calendar.

List all degree credit exclusions, prerequisites, integrated courses, and notes below the course description.

Not applicable.

Expanded Course Description:

Please provide a detailed course description, including topics / theories and learning objectives, as it will appear in supplemental calendars.

This course is designed to provide physics students with a true cloud-based toolkit in research in the context of data science and a student led project. The course is designed (as shown in Figure 1) to introduce both some of the modern software programs, data tools and statistical packages which are an increasingly vital part of the toolbox needed to do modern research and solve advanced problems in modern science.

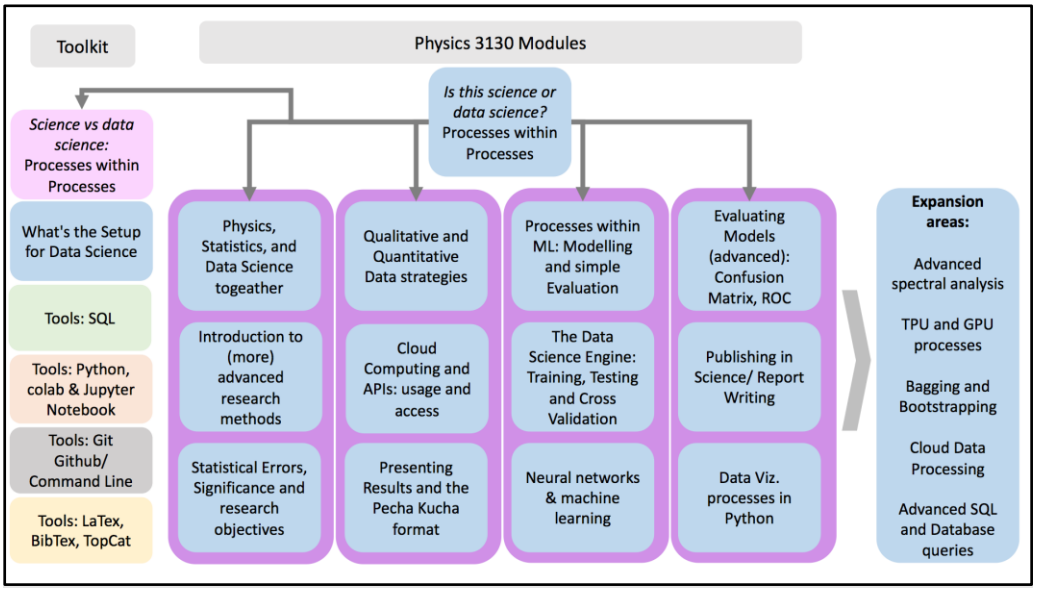


Figure 1: Module layout of course showing major components, tools, and optional additional modules for advanced students

The course will be Python and cloud centric. As well as being one of the most dominant in academic and industrial environments, Python is commonly used in Data Science, one of the largest areas of employment for science degrees. To broaden exposure to the data science landscape, basic database operations will also be introduced (e.g., SQL).

Setting at the 3000 level, this course provides a bridge to more advanced methods. Students may find this course a helpful precursor to research and 4000 level courses like PHYS 4030, 4270, 4310 and more. The level of statistics included in this course will assume knowledge from PHYS 2213, 2030 or equivalent and provide examples of how/and when to use various methods on diverse types of data (discrete, continuous, nominal, and ordinal).

The data science landscape includes many valuable tools, and in this course, we will focus on those specifically of assistance to physics and astronomy students. Students will be required to use Python for the homework and project components of the course.

Learning Objectives

- Use and differentiate basic data science methods in physics and

astronomy *[Physics Program Learning Outcomes: Physics 2.a-e, 6.d]*

- Apply statistical tools to achieve research objectives *[Physics Program Learning Outcomes: Physics 1.b, 3.b]*
- Conduct a data science investigation utilizing inferential and deductive methods *[Physics Program Learning Outcomes: Physics 2.c]*
- Identify the most appropriate research methodologies and methods for the specific case at hand *[Physics Program Learning Outcomes: Physics 3.a, 3.b]*
- Conduct a scientific or data science research project using astronomy, physics, or biophysics data. *[Physics Program Learning Outcomes: Physics 3.e, 3.f]*
- Explain and conduct a Literature and Theory Review of their project topic. *[Physics Program Learning Outcomes: Physics 4.a, 4.b, 4.c]*
- Identify complications in data sets *[Physics Program Learning Outcomes: Physics 2.b, 3.a]*
- Effectively communicate in writing data science concepts. *[Physics Program Learning Outcomes: Physics 4.a]*
- Demonstrate written communication, numeracy, and critical thinking skills. *[Physics Program Learning Outcomes: Physics 1.b, 1.c, 3, 6.d]*

Potential Topics

This list highlights salient course topics. Specific examples to employ for each are instructor-dependent, to allow flexibility and innovation.

1. Research Methods
2. Basics of Tools: Command Line, Python, collaborative programing environments, LaTeX, Astronomical database tools
3. Identifying and using databases.
4. Data Science Basics
5. Cloud Computing and application programming interfaces (APIs)
6. Python and database languages (with focus on SQL-type databases) together supporting research
7. Qualitative and Quantitative Data, collection, and statistics
8. Statistical Tests, inferential and descriptive
9. Advanced Data Analysis, retrieving data from online databases
10. Publishing in Science/Report Writing
11. Neural Nets and Advanced Machine Learning Methods

**Future cross listing opportunities: Math, Atmospheric Science

Course Design:

Indicate how the course design supports students in achieving the learning objectives. For example, in the absence of scheduled contact hours what role does student-to-student and/or student-to-instructor communication play, and how is it encouraged?

Detail any aspects of the content, delivery, or learning goals that involve "face-to-face" communication, non-campus attendance or experiential education components.

Alternatively, explain how the course design encourages student engagement and supports student learning in the absence of substantial on-campus attendance.

This course is based around a student project. The course will be designed to support the project with lectures on research methods and tools, computational demonstrations, collaborative synchronous activities, and supervised coding practice sessions.

This class is designed to run in a computer lab (LECT format) synchronously so that students can troubleshoot in real-time. The lecture-based components are weighted toward the beginning and middle of the course, with exercises aimed towards the last half. The lectures will include time for group discussion/coding on topics related to student projects and on the projects themselves. The project assignment will have milestones (e.g., early "literature review") with staggered and graded deadlines to ensure that work on it is conducted throughout most of the semester. Motivation for topics will be introduced early in the course to help students generate excitement and start planning. Further, feedback would be provided (e.g., critical input to help refine initial drafts of a project proposal/hypothesis). Homework assignments will be designed to make sure that students can use the tools introduced, Python, using databases and Data Science Methods in particular.

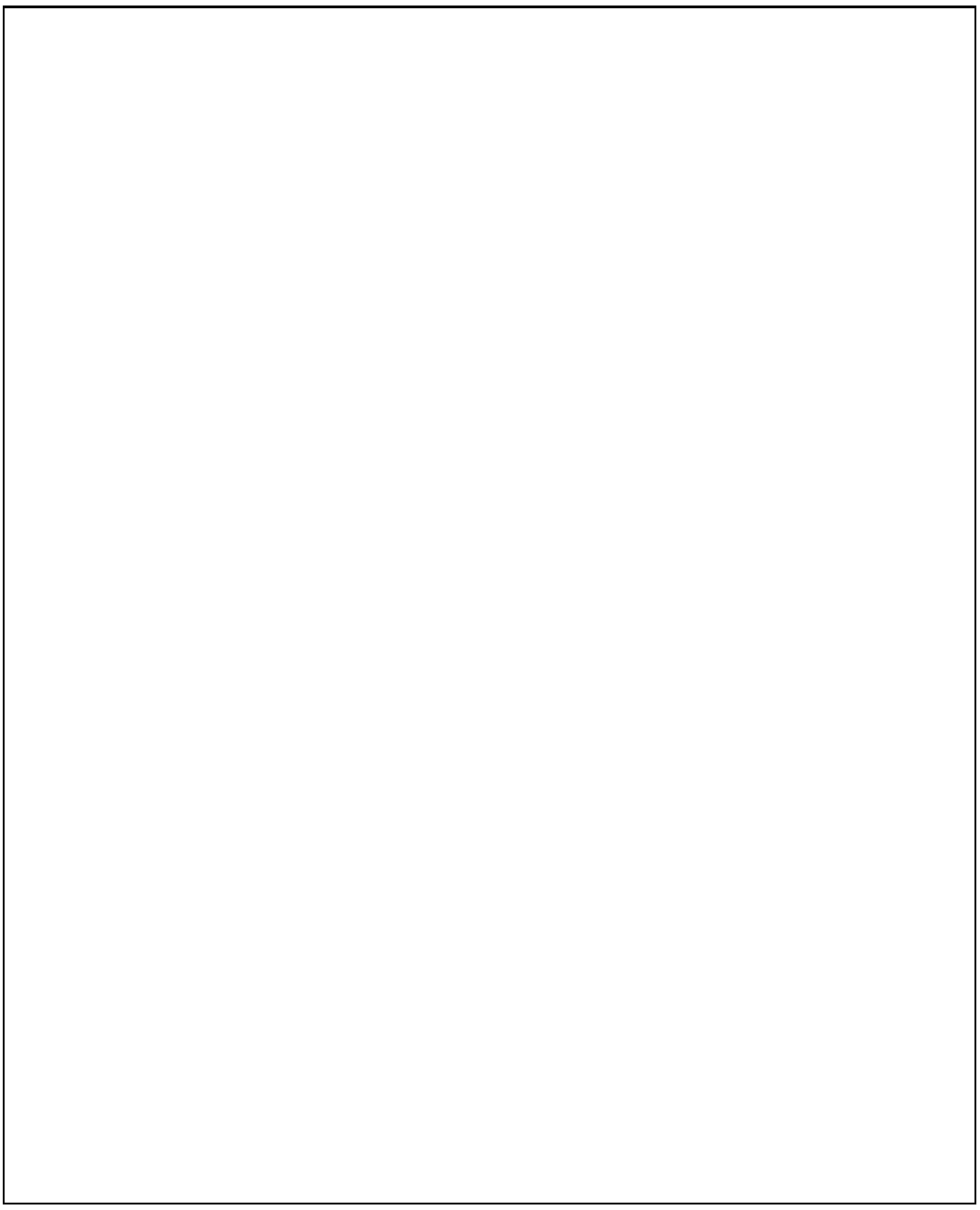
Example projects could include:

Astrophysics:
Classify stellar groups from existing data. Use color and magnitude information to separate members of star clusters from background and foreground stars. This project can be expanded to other measured properties for stars such as velocity, metallicity, and temperature. Other projects could include galaxy classification, supernova remnant searches and globular cluster characterization.

Physics: The 'Icecube' experiment is designed to detect cosmic ray neutrinos. The experiment is located in the Antarctic. One project could see students use publicly available Icecube data to examine neutrino paths. Other projects could include particle masses, charges, and velocities from physics as well as dark matter studies and particle modelling (charged particle tracks).

Biophysics:
Analysis of biological specimen datasets to classify plant or animal types from image or measurement data. Medical measurements from imaging data. The CheXpert task is a publicly available dataset of chest x-rays and associated measurement which is ideal for neural networks. Biomechanics algorithms that learn to track joint angles from markerless video data (e.g., using DeepLabCut) and students can have video or audio of themselves or their pets and make a system that tracks their joints or learns from sounds.

Mode of Delivery: LECT



Instruction:

1. Planned frequency of offering and number of sections anticipated (every year, alternate years, etc.).
2. Number of department members currently competent to teach the course.
3. Instructor(s) likely to teach the course in the coming year.
4. An indication of the number of contact hours (defined in terms of hours, weeks, etc.) involved, in order to indicate whether an effective length of term is being maintained **OR** in the absence of scheduled contact hours a detailed breakdown of the estimated time students are likely to spend engaged in learning activities required by the course.

1. One section expected in the Winter or Fall term of each year.

2. Elaina Hyde, Christopher Bergevin, Joel Zylberberg, TBA

3. Elaina Hyde

4. There will be three lecture hours per week in LECT format, with the option of adding a tutorial session of 1 hour if the course moves from optional to required status in the department. Delivery will be synchronous.

Evaluation:

A detailed percentage breakdown of the basis of evaluation in the proposed course must be provided.

If the course is to be integrated, the additional requirements for graduate students are to be listed.

If the course is amenable to technologically mediated forms of delivery please identify how the integrity of learning evaluation will be maintained. (e.g. will "on-site" examinations be required, etc.)

In order to take into consideration, the principles of universal course design (flexible, accessible, enabling students to make choices and be more involved in the learning process), the final grade for the course will be based on:
Student Notebook Submissions (Homework and Quizzes)
Project Midway Results
Project End Results (including physics knowledge)
Student Presentations

The course would have four major graded components: homework (i.e., Python code-based problem sets), a quiz component (checking general knowledge), a presentation (at the end of the semester) and the project (which will be broken into parts).

- Homework (Python notebooks): 25%
- Quizzes (Checking of Data Science general knowledge): 10%
- Class Presentation (on your project knowledge): 15%
- Project Part 1 (Literature Review, Initial Data Analysis, and first-pass ML (Machine Learning) setting up the project parameters): 15%
- Project Part 2 (Final results, final literature/theory review, astrophysics results, full code, and conclusion): 35%

Bibliography:

A READING LIST MUST BE INCLUDED FOR ALL NEW COURSES

The Library has requested that the reading list contain complete bibliographical information, such as full name of author, title, year of publication, etc., and that you distinguish between required and suggested readings. A statement is required from the bibliographer responsible for the discipline to indicate whether resources are adequate to support the course.

Also please list any online resources.

If the course is to be integrated (graduate/ undergraduate), a list of the additional readings to be required of graduate students must be included. If no additional readings are to be required, a rationale should be supplied.

LIBRARY SUPPORT STATEMENT MUST BE INCLUDED.

Library Support Statement

Appended to the end of this document, c/o Minglu Wang. - TBA

References

o Giordano, N. J., & Nakanishi, H. (2006). *Computational Physics*.

o Ivezić, Ž., Connolly, A. J., VanderPlas, J. T., & Gray, A. (2014). *Statistics, data mining, and machine learning in astronomy: a practical Python guide for the analysis of survey data* (Vol. 1). Princeton University Press.

o Kinder J.M. and Nelson P. (2015) *A student's guide to python for physical modeling*, Princeton University Press.

o Kutz, J. N. (2013). *Data-driven modeling & scientific computation: methods for complex systems & big data*. Oxford University Press.

o Langtangen H.P. (2014) *A primer on scientific programming with Python*, Springer.

o Taylor, J. (1997), *An introduction to Error Analysis*. University Science Books

o VanderPlas, J. (2016). *Python data science handbook: essential tools for working with data*. O'Reilly Media, Inc.

o Collis, J., & Hussey, R. (2013). *Business research: A practical guide for undergraduate and postgraduate students*. Macmillan International Higher Education.

Online resources available for students include, but are not limited to the following free and open-access resources:
Python, Python Libraries, CoLab, SQL, GIMP, GitHub, ds9, IRAF, SIRIL, TopCat, SQLite, Docker, and other smaller resources. No paid resources are required for this course.

Other Resources:

A statement regarding the adequacy of physical resources (equipment, space, etc.) must be appended. If other resources will be required to mount this course, please explain

COURSES WILL NOT BE APPROVED UNLESS IT IS CLEAR THAT ADEQUATE RESOURCES ARE AVAILABLE TO SUPPORT IT.

No new lab space is required for this course. Students will use their own computers or campus computing labs [e.g., Advanced Multimedia Lab (AML)/Gauss Lab in Ross, maintained by the Department of Mathematics and Statistics]. For those requiring more advanced computational power (e.g., project dealing with deep learning), additional resources and options will be explored in conjunction with FSc's Director of Information Technology and Google Cloud facilities.

A computer classroom is required in LECT mode, and 1 or more TAs will be needed to support grading of assignments (depending on student enrollment numbers).

Course Rationale:

The following points should be addressed in the rationale:

How the course contributes to the learning objectives of the program / degree.

The relationship of the proposed course to other existing offerings, particularly in terms of overlap in objectives and/or content. If inter-Faculty overlap exists, some indication of consultation with the Faculty affected should be given.

The expected enrolment in the course.

Background:

As the future of physics and all of science becomes more and more integrated with big data, data science and programming, an overall view of the environment and tools becomes increasingly important to all FSc students. This course fills a unique niche which is currently under addressed in any of our other science courses. As mentioned in the J-TUPP report (Joint Task Force on Undergraduate Physics Programs) run by the APS, NSF and AAPT: *"the skills needed by college graduates to best prepare them for 21st century careers include working well in teams, understanding how science and technology are used in real-world settings, writing and speaking well, and understanding the context in which work is now done."*

In the time I have been in York I have seen first-hand how unprepared and lacking in basic data science methodology students emerging from our curriculum currently are. Most students do not know the key tools of 'Co-lab', 'TopCat,' 'Anaconda' or key database techniques like 'SQL' and historically many have underutilized Python programming skills. In the context of the J-TUPP report this is a lack of understanding of the context in which scientific work is now done. This lack, however, does not correspond with any lack of desire to learn.

I successfully implemented small coding demos in my PHYS 1412 class (second semester first-year physics for non-majors) class. Not only was the entire class able to run the codes and enjoy them (with no prior experience!), but one of my first students used the code basis to create a successful small business. The student in question adapted some sound

code that we had used and now sells unique audio imprints on artwork and clothing, which is quite the crossover event.

As a previous co-instructor for PHYS 4030 (Advanced Computational Methods), the lack of time to cover the computing environment and data science tools was one of the factors that led to this proposed course. PHYS 4310, which is the Physics/Astronomy project course, is also well supported by this course in both the tools and project areas.

The above and other successes at York led me to trial a one-credit data science minicourse for graduate students and qualified undergraduates in summer 2020 and 2022, running a short but intense set of material. All 6 of our initial 2020 summer students produced high quality machine learning projects in only 4 weeks. In 2022 all 9 students produced successful high-quality projects in only 4 weeks.

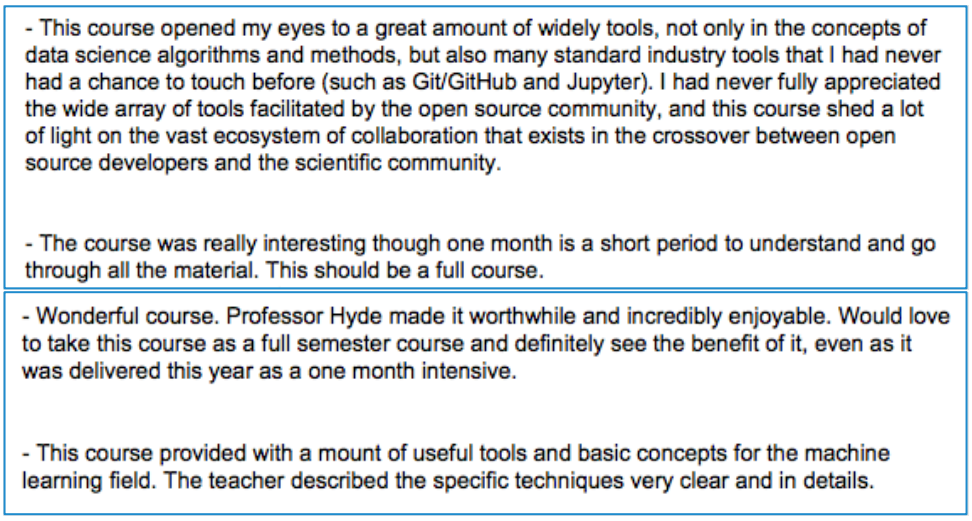


Figure 2: Sample student reviews (anonymous) from 2022 PHYS 6202 mini course. As seen, students appreciate the material but request a longer course on this subject.

As shown in the selected feedback from Figure 3, although students appreciated the material, the minicourse was too short to cover everything needed in detail. Additionally, with the compressed time limit many areas of cloud computing were not covered.

Support for this material was additionally shown in my successful Academic Innovation Fund (AIF) Category IV grant in 2020 with the project title: *'Teaching Python and Data Science skills to Science Undergraduates'*. With this grant I developed several modules for the PHYS 6202 course which will be applicable to this course.

A sample of typical demonstrations for this class in a cloud environment were given to the department at the York Physics and Astronomy Journal Club (currently the Anarchic Astronomy Journal Club or AAJC) on 11/08/2021 as a supplement for professors, students and faculty who were interested (but who, for assorted reasons could not attend the 6202 course). The AAJC cloud and physics demo was sent to the department

shortly after presentation. The code is meant to be run interactively and can be found here: https://colab.research.google.com/drive/1Ady8YIWFDImKmNgEhHbdmEfRAvao_zyc?usp=sharing

The feedback from both 2020 and 2022 delivery of our mini course was overwhelmingly positive but noted this lack of time strongly, therefore, this broader and more comprehensive class is proposed. This class is not only filling a notable gap in our curriculum but is also providing some of the valuable data science skills that our students have been clamoring for.

- Prof. Elaina Hyde

Contribution to program learning objectives:
This course brings additional opportunities for developing computational expertise to the full range of science students and sets them up with the skills that contribute to existing courses as well as being valuable to matriculating students. Strong computational abilities are commonly sought-after qualifications in employers in academia, industry, and government, and there is a powerful desire among our students for transferable skills in data science and programming. These skills will allow our students to apply more easily what they have learned in their science degree to a wide possibility of careers ranging from laboratory work through to the finance industry.

This course will draw primarily from students specializing in physics, astrophysics, math, and biophysics, but is open to any science major who has completed first-year physics and computing (PHYS 2213, 2030) and has some experience in computing at the second-year level. (If that experience is informal, permission from the instructor can be secured to take the course.)

Relationship to existing offerings at York:
The practical applied computational content from this course is not included in PHYS 2213, 2030 and PHYS 4030. Students may additionally find this course a helpful precursor to research and 4000 level courses like PHYS 4030, 4270, 4310 and more. This course proposal is distinct from PHYS 4030 in that this course aims to establish a broad base of widely applicable skills, whereas PHYS 4030 aims to help students develop greater expertise in a narrow area of application. For example, in 4030 parts of 'Deep Learning' including the Monte Carlo methods and partial differential equations are used in a coding environment. This course will show students how to apply those tools (as well as others like neural nets and KS-testing) in a cloud environment, as well as introducing the broader data science ecosystem (i.e., GPU (Graphics Processing Unit) and TPU processes in Machine Learning). This course approaches data science as both a learning method and a tool for students. Unlike other Data Science courses in York, this class specifically aids science

students in building a skillset that will be robust for science in Physics and Astronomy areas. Following the new Data Science track with the Math department, the possibility of cross listing this course in the Math and Statistics area will allow for seamless integration with existing resources.

Relationship to similar offerings at other universities:
Comparable institutions/programs (e.g., McMaster) typically provide one to two computational courses for undergraduate physics and biophysics majors. Due to the lack of introductory courses, we have recently seen a rise in supplementary courses such the 'Data Analytics Bootcamp' which is run with a registration fee at the University of Toronto and the ongoing popularity of General Assembly Data Science paid courses in the Toronto area.

A preliminary search for courses in Data Science in Canada currently include universities such as McGill, University of Toronto, University of British Columbia, Simon Fraser University and Queen's University. With the rising interest, there has never been a better time to introduce a course that will fill these needs for our students.

This course will be complimentary to the new, York University, Data Science program based in the Math department (available at: https://futurestudents.yorku.ca/program/data-science). Computation stream advisors have suggested a cross-listing opportunity for this class to provide an elective that will support the existing capstone course. Since this course is tailored for physics and astronomy majors it will provide valuable tools and context not seen on any existing stream (the current 2023 list is: Business, Health, Computational Arts, Optimization and Computation).

Expected enrolment:
10-30 students/year.

Faculty and Department Approval for Cross-listings:

If the course is to be cross-listed with another department, this section needs to be signed by all parties. In some cases there may be more than two signatures required (i.e. Mathematics, Women's Studies). In the majority of the cases either the Undergraduate Director or Chair of a unit approves the agreement to cross-list. All relevant signatures must be obtained prior to submission to the Faculty curriculum committee.

Dept:	_____ Signature (Authorizing cross-listing)	_____ Department	_____ Date
Dept:	_____ Signature (Authorizing cross-listing)	_____ Department	_____ Date
Dept:	_____ Signature (Authorizing cross-listing)	_____ Department	_____ Date

Accessible format can be provided upon request.

June 8, 2023

PHYS 3130: Practical Data Science Methods in Physical Sciences

I have reviewed the course proposal and bibliography for **PHYS 3130: Practical Data Science Methods in Physical Sciences** and can state that the York University Libraries have the required resources to support this course.

I have searched the course bibliography in our library collection. We currently have all the reference books either in electronic or hard copy format. I have ordered an updated version of one of the reference books and an additional eBook version of one of them. Please see the availability notes below for each of the title in the reference list:

o Giordano, N. J., & Nakanishi, H. (2006). *Computational Physics*. **[no eBook available, ordered a hard copy]**

o Ivezić, Ž., Connolly, A. J., VanderPlas, J. T., & Gray, A. (2014). *Statistics, data mining, and machine learning in astronomy: a practical Python guide for the analysis of survey data* (Vol. 1). Princeton University Press. **[both this version and an updated version are available online through library]**

o Kinder J.M. and Nelson P. (2015) *A student's guide to python for physical modeling*, Princeton University Press. **[a 2nd edition (2021) hard copy is in library collection and currently checked out, a second copy is ordered, no eBook available]**

o Kutz, J. N. (2013). *Data-driven modeling & scientific computation: methods for complex systems & big data*. Oxford University Press. **[available online through library]**

o Langtangen H.P. (2014) *A primer on scientific programming with Python*, Springer. **[available online through library]**

o Taylor, J. (1997), *An introduction to Error Analysis*. University Science Books **[no eBook available, library has hard copy, an updated edition (2022) is ordered]**

o VanderPlas, J. (2016). *Python data science handbook: essential tools for working with data*. O'Reilly Media, Inc. **[eBook is available online through library]**

o Collis, J., & Hussey, R. (2013). *Business research: A practical guide for undergraduate and postgraduate students*. Macmillan International Higher Education. **[no eBook available, a hard copy is ordered]**

If you would like to select books or digitize course reading content and place them on reserve at the library for students' use, please place a reserve request by visiting reserves.library.yorku.ca. For more information about course reserves, please visit: http://www.library.yorku.ca/web/ask-services/facultyinstructor-support/places-items-on-reserve/.

If the course will provide additional readings to students on Moodle, copyright compliance instruction may be requested through York University's Copyright Support Office: http://copyright.info.yorku.ca.

The following electronic resources licensed by the library may also be of help to the students in this course:

Electronic Resources
- Subscription-based resources such as INSPEC via Engineering Village, Web of Science, Scopus, and others.

E-Books Packages
- Numerous electronic book packages such as Elsevier, Taylor & Francis, Cambridge University Press, Oxford Scholarship Online, SPIE Digital Library, Springer E-Books, and others.

E-Journal Packages

- Numerous electronic journal packages such as American Institute of Physics, American Physical Society, Elsevier, Nature, Optical Society of America, Springer. SPIE Digital Library, Taylor and Francis, Wiley, and others.

Please note that journal articles, books, and other library resources that are not part of York University Libraries' collection may be borrowed through interlibrary loan via RACER. RACER registration and requesting is available from: http://www.library.yorku.ca/web/ask-services/borrow-renew-return/racer-interlibrary-loan/.

Collection development in the library is ongoing and is based on a commitment to developing library resources that are in alignment with the University's curricular and research activities. Additional books in this field will be added to the library collection as they are published. Please forward any requests for purchase to the Physics & Astronomy Subject Librarian Minglu Wang (mingluwa@yorku.ca) or submit your purchase request by using the form at http://www.library.yorku.ca/web/suggestion-for-purchase-form/.

In addition, York University librarians provide research support in the following ways:

- One-on-one research consultations. Please contact the Physics & Astronomy Subject Librarian Minglu Wang (mingluwa@yorku.ca) for an appointment.
- Custom workshops tailored to a course. Possible topics include but are not limited to:
    - Understanding the scholarly communication cycle.
    - Developing a strategy for searching databases such as INSPEC, Web of Science, Scopus, and others using keywords and controlled vocabulary.
    - Managing references using citation management software such as Mendeley or Zotero.
- A Physics and Astronomy subject guide has been created and is maintained by subject librarians. Resources and links will be added upon request:
    - http://researchguides.library.yorku.ca/physics
    - http://researchguides.library.yorku.ca/astronomy

In summary, the library is well situated to support this course.

Sincerely,

Minglu Wang
Research Data Management Librarian / Science Librarian
102J Steacie Science and Engineering Library
136 Campus Walk, Keele Campus, York University
North York, ON M3J 1P3
Tel: (416)736-2100 ext. 40075

YORK
UNIVERSITÉ
UNIVERSITY

FACULTY OF SCIENCE

Department of
Physics & Astronomy

128 PETRIE SCIENCE &
ENGINEERING BLDG.
4700 KEELE ST.
TORONTO ON
CANADA M3J 1P3
T 416 736 5249
F 416 736 5516
www.physics.yorku.ca

June 19, 2023

Dear Faculty of Science Curriculum Committee,

This letter is to express our support for the proposed course PHYS 3130 3.0 Practical Data Science Methods in Physical Sciences.

This course will give our students an opportunity to further enhance their computational skills, expose them to the tools and techniques of data science, and to apply these tools and techniques to physics and astronomy. These opportunities are not found in other courses in our program.

This proposal was unanimously approved by the department earlier this month.

Sincerely,

Patrick B Hall

Patrick Hall
Chair
Department of Physics and Astronomy

Matthew George
Undergraduate Program Director

Changes to Existing Course

Faculty: Science

Department:	Physics and Astronomy	**Date of Submission:**	Spring 2023
Course Number:	SC/PHYS 4020 3.0	**Effective Session:**	Fall 2024
Course Title:	Electromagnetics II		

Type of Change:

[X]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200 characters)	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
Time-dependent electric and magnetic fields, Maxwell's differential equations in linear, isotropic, homogeneous conductors and dielectrics; the radiation and transmission of electromagnetic energy; relativistic transformation; scalar diffraction theory. Prerequisites: SC/PHYS 3020 3.00; SC/PHYS 2040 3.00	Time-dependent electric and magnetic fields, Maxwell's differential equations in linear, isotropic, homogeneous conductors and dielectrics; the radiation and transmission of electromagnetic energy; relativistic transformation; scalar diffraction theory. Prerequisites: SC/PHYS 3020 3.00; recommended SC/PHYS 2040 3.0

Rationale:

Changing PHYS 2040 from an implied necessary prerequisite to a recommended prerequisite.

PHYS 2040 3.0 *Relativity and Modern Physics* introduces students to the posulates of special relativity which are foundational for the PHYS 4020 topic of relativistic transformations. However, relativistic transformation is minor section of PHYS 4020, and the salient points of relativity are reintroduced. Further, the textbook contains a full and complete treatment of the relativity required without assuming prior knowledge.

Secondly, students in our Biophysics program struggle to fit PHYS 2040 into their schedules, and therefore would otherwise be ineligible to take the centrally important PHYS 4020 Electromagnetics II, which is a requirement for many graduate programs.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: SC

Department:	NATS/STS	**Date of Submission:**	30-May-2023
Course Number:	NATS1920A	**Effective Session:**	FW24-25
Course Title:	THE NATURE AND GROWTH OF IDEAS IN MATHEMATICS		

Type of Change:

[ ]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[X]	in title (max. 40 characters for short title)	[ ]	in course format/mode of delivery *
[X]	in Calendar description	[ ]	retire/expire course
[ ]	other (please specify):	[ ]	

Change From:	**To:**
TITLE: The Nature and Growth of Ideas in Mathematics CALENDAR DESCRIPTION: Students are shown the central position of mathematics in our culture: great discoveries in mathematics and their effect on general culture and society; history of mathematics; mathematics of art and architecture, sound, games and gambling and computing.	TITLE: Great Mathematical Minds CALENDAR DESCRIPTION: Like great pieces of art and literature, mathematical theorems have revolutionized the world. This course introduces students to history's most transformative mathematical theorems. Each theorem is explored in its historical context with a focus on the mathematics and the mathematician. Students will learn of the greatest mathematicians of all time, their often quirky or contentious personalities, and their turbulent lives. Mathematical topics may include Egyptian Numerals, Base 60, Geometry, Algebra, Sequences and Series, Number Theory and Probability. No particular background in mathematics is required. This course is accessible to anyone with an interest in gaining knowledge of the basics of mathematics and acquiring useful quantitative problem-solving skills.

Commented [RM1]: Title change as per recommendation by FSc Curriculum

Commented [RM2]: Revised as per FSc Curriculum friendly amendment to remove 'This course is accessible to anyone with a desire to learn...'

Rationale:

For a number of years, this course was taught by a full-time faculty member in the MATH department. In 2020, NATS hired a full-time faculty member specializing in math eduction for non-science majors. This faculty member has overhauled the course to include updated material and assessments, with the goal of making the course more attractive to non-science majors who would benefit from improving their quantitative problem solving skills. The revised course description and course title are more compelling and more accurately reflect what students will gain from the course.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Changes to Existing Course

Faculty: SC

Department:	NATS/STS	**Date of Submission:**	14-Jul-2023
Course Number:	NATS1880 6.0	**Effective Session:**	FW24-25
Course Title:	LIFE BEYOND EARTH		

Type of Change:

- [ ] in pre-requisite(s)/co-requisite(s)
- [ ] in course number/level
- [ ] in credit value
- [ ] in title (max. 40 characters for short title)
- [ ] in Calendar description
- [ ] in cross-listing
- [ ] in degree credit exclusion(s)
- [ ] regularize course (from Special Topics)
- [ ] in course format/mode of delivery *
- [ ] retire/expire course
- [X] other (please specify): CCEs and NCRs

Change From:	To:
CALENDAR DESCRIPTION: This course considers the various factors required for life to exist beyond Earth, both life that may have evolved elsewhere and what would be necessary for humans moving out into space. Course credit exclusions: SC/NATS 1570 3.00, SC/NATS 1740 6.00. NCR: any student in the Astronomy stream nor to any student who has passed or is taking SC/PHYS 1070 3.00, SC/BIOL 1010 6.00, SC/BIOL 1000 3.00, SC/BIOL 1001 3.00 or AP/ANTH 3270 3.00.	CALENDAR DESCRIPTION: This course considers the various factors required for life to exist beyond Earth, both life that may have evolved elsewhere and what would be necessary for humans moving out into space. Course credit exclusions: SC/NATS 1570 3.00, SC/NATS 1572 3.00, SC/NATS 1740 6.00. NCR: any student in the Astronomy stream or ~~nor to~~ any student who has passed or is taking SC/PHYS 1070 3.00~~, . SC/BIOL 1010 6.00, SC/BIOL 1000 3.00, SC/BIOL 1001 3.00 or AP/ANTH 3270 3.00.~~

Rationale:

Addition of CCE NATS1572 Intro to Astrobiology: NATS1572 is a new, 3-credit version of NATS1880. NATS1880 is listed as a CCE for NATS1572 and therefore needs to be reciprocated as a CCE for NATS1880.

Removal of 1st-year biology courses as NCR: The initial inclusion of these courses as NCRs was to prevent Biology students from having an unfair academic advantage in the course. However, in the updated iterations of this course, this is not an issue as NATS1880 spends only a small emount of time on biology fundamentals – the rest of the material pertains to topics not covered in these Biology courses. Note that NATS1572 Intro to Astrobiology, which covers the life-science topics in NATS1880, does not list 1st-year Biology courses as NCRs owing to its specialized content. NATS1880 does not need these NCRs for the same reason.

Removal of ANTH 3270 3.00 The Antropology of Outer Space: This third-year, 3-credit course looks at space exploration through an anthropological lens. It does not cover the physical or life science concepts to the extent that they are taught in NATS1880. A student who has taken ANTH 3270 would not have an unfair academic advantage in NATS 1880 owing to the emphasis of science content in NATS 1880.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

COMMITTEE ON ACADEMIC STANDARDS, CURRICULUM AND PEDAGOGY TEMPLATE

NEW COURSE PROPOSAL FORM

Faculty: Indicate all relevant Faculty(ies)	Science

Department: Indicate department and course prefix (e.g. Languages, GER)	Natural Science	**Date of Submission:**	7-Jul-2023

Course Number: Special Topics courses Include variance (e.g. HUMA 3000C 6.0, Variance is "C")	NATS 1572	**Var:**	**Academic Credit Weight:** Indicate both the fee, and MTCU weight if different from academic weight (e.g. AC=6, FEE=8, MET=6	3	

Course Title: The official name of the course as it will appear in the Undergraduate Calendar and on the Repository	Introduction to Astrobiology

Short Title: Appears on any documents where space is limited - e.g. transcripts and lecture schedules - **maximum 40 charactersl**	Introduction to Astrobiology

With every new course proposal it is the Department's responsibility to ensure that new courses do not overlap with existing courses in other units. If similarities exist, consultation with the respective departments is necessary to determine degree credit exclusions and/or cross-listed courses.

Brief Course Description:

Maximum 2000 characters (approximately 300 words including spaces and punctuation).

The course description should be carefully written to convey what the course is about. It should be followed by a statement of prerequisites and co-requisites, if applicable. This description appears in the calendar.

For editorial consistency, and in consideration of the various uses of the Calendars, verbs should be in the present tense (i.e., "This course analyzes the nature and extent of...," rather than "This course will analyze...")

Human beings have long desired to travel amongst the stars and answer the enduring question of whether or not we are alone in the Universe. While the space environment and other planets may not possess the ideal conditions for life as we know it on Earth, life has proven itself to be resilient in a variety of extreme environments. This course begins by introducing students to the biology of life on Earth. Students then learn how different lifeforms are affected by the space environment and what steps can be taken to mitigate these effects in order for life to survive in space. We then look beyond Earth and evaluate the habitability of other moons and planets, both in our solar system and beyond. Finally, we discuss the search for alien life and potential theories of how alien life might form and develop on other worlds.

No previous background in Astronomy, nor any science, is required. Students will find it helpful to have taken NATS1570 3.0 Exploring the Solar System either before or concurrently with NATS1572, though NATS1570 is not required in order to be successful in this course.

Co/Prerequisites: None
CCE: SC/NATS1880 6.0
NCR: None

Generic Course Description:

This is the description of the "Parent / Generic course" for Special Topics courses under which variances of the "Generic" course can be offered in different years (Max. 40 words). Generic course descriptions are published in the calendar.

List all degree credit exclusions, prerequisites, integrated courses, and notes below the course description.

Students examine the biology of Earth-based life and learn how microbial, plant, and animal lifeforms are affected by the space environment and by conditions on other worlds. Students evaluate the habitability of other worlds, explore methods that search for life beyond Earth, and examine the potential biology of alien life.

Co/Prerequisites: None
CCE: SC/NATS1880 6.0
NCR: None

Expanded Course Description:

Please provide a detailed course description, including topics / theories and learning objectives, as it will appear in supplemental calendars.

Topics:

The course first defines "life as we know it" before breaking down lifeforms into three categories: (1) Microbial Life, (2) Plant Life, and (3) Animal Life. Students then learn how each of these types of lifeforms are affected by the space environment (gravity, vacuum, temperature, space radiation) given the results of Earth-based and space-based experiments. Students also explore the steps that can be taken in order for lifeforms to survive in space and in the potential environments of other worlds. The course ends with an exploration of how alien life might develop on other worlds and methods for finding such life. An outline of the course's major themes is provided below:

1. The Biology of Life

- Definition of Life
- Different Types of Lifeforms (microbial, plant, animal)

2. The Space Environment

- Gravity
    - Strong Gravity During Launch
    - Microgravity in Orbit
- Temperature and Pressure
- Space Radiation
- Space Ships and Space Stations
    - What environmental factors can be controlled and what environmental factors are unavoidable?

3. Life in Space (microbial, plant, animal)

- Life in Microgravity
- Life at Low Temperatures
- Life in a Vaccuum
- Effects of Space Radiation on Life

4. Searching for Life in the Universe

- Possible locations for life in our solar system
    - Venus, Mars, Europa, Enceladus, Titan, Io
- Where could Earth-based life live in our solar system?
    - Humans on the Moon and Mars
    - Colonization: The Ethics and Biological Processes involved in Living on Other Worlds and Making Other Worlds Like Earth (terra-forming)
- Possible locations for life beyond our solar system
    - The Habitable Zone
    - Exoplanet Atmospheres

    - Potentially Habitable Exoplanets
- Biosignatures of Life on Other Worlds
- Biological Solutions to Fermi's Paradox
    - Why haven't we found Aliens...yet

5. <u>Alien Biology</u>

- Alternatives to Life As We Know It
    - Life without water
    - Life without carbon

Learning Outcomes:

Upon successful completion of this course students should be able to:

- Define life as we know it, while recognizing the limitations of such a definition
- Explain the scientific method and describe and evaluate problem-solving methods used by scientists in the search for life on other worlds
- Describe how different types of lifeforms (microbial, plant, animal) are affected by the space environment and discuss strategies for mitigating any negative effects
- Evaluate the habitability of other worlds in our solar system and beyond for Earth-based life
- Discuss ideas of how different types of extraterrestrial lifeforms (ie, alien life) may form and evolve on other worlds
- Formulate informed opinions on the value of the search for life and the human impact of the discovery of life beyond Earth

Course Design:

Indicate how the course design supports students in achieving the learning objectives. For example, in the absence of scheduled contact hours what role does student-to-student and/or student-to-instructor communication play, and how is it encouraged?

Detail any aspects of the content, delivery, or learning goals that involve "face-to-face" communication, non-campus attendance or experiential education components.

Alternatively, explain how the course design encourages student engagement and supports student learning in the absence of substantial on-campus attendance.

This course can be delivered in either the in-person (LECT) format, the blended format (BLEN), or as an online, asynchronous course with in-person exams (ONCA). The range of delivery formats provides students with flexibility when scheduling their courses, thereby increasing the likelihood that they can find a course in their area of interest.

The breakdown of each format is as follows:

LECT: All components of the course (i.e. lectures, in-class activities, midterms, and final exams) are held in-person. In-class activities will consist of active learning exercises such as clicker surveys, pop talks, think-pair-share sessions, and hands-on activities and demonstrations in support of the projects (described in the evaluation scheme below).

BLEN: All lectures will be delivered asynchronously online. In-person sessions will take place every second or third week, during which students will complete the active learning components described in the LECT section above. Clicker activities will be replaced with online quizzes to be taken after viewing lecture videos, to ensure students come prepared to participate in-class activities.

ONCA (summer term only): All lectures will be delivered asynchronously online. Clicker activities will be replaced with online quizzes to be taken after viewing lecture videos. Demonstrations and pop-talks can be pre-recorded and posted for students to view and engage with in online forum discussions. Think-pair-share sessions can be conducted via online forum discussions. Hands-on activities will be designed for students to complete at home.

Instruction:

1. Planned frequency of offering and number of sections anticipated (every year, alternate years, etc.).
2. Number of department members currently competent to teach the course.
3. Instructor(s) likely to teach the course in the coming year.
4. An indication of the number of contact hours (defined in terms of hours, weeks, etc.) involved, in order to indicate whether an effective length of term is being maintained **OR** in the absence of scheduled contact hours a detailed breakdown of the estimated time students are likely to spend engaged in learning activities required by the course.

1. It is anticipated that the course will be offered every winter term, as a Part 2 to NATS1570 Exploring the Solar System, though NATS1572 can be taken on its own. It may also be offered in the summer based on popularity.

2. Currently there are 2 NATS faculty members competent to teach the course (Jeremy Webb and Mary-Helen Armour). Paul Delaney (Professor Emeritus from the Dept of Physics and Astronomy) is also competent to teach this course. It may also be taught by qualified faculty in the Dept of Physics and Astronomy (e.g., Sarah Rugheimer, when available).

3. Jeremy Webb is expected to teach the initial offering of this course in the LECT format.

4. There will be approximately 2-2.5 hours of lecture contact and 0.5-1 hour of learning activities per week (in-person or asynchronous online) for a total of 36 hours, with the course director also being available via weekly office hours, online help sessions, online forums and email.

Evaluation:

A detailed percentage breakdown of the basis of evaluation in the proposed course must be provided.

If the course is to be integrated, the additional requirements for graduate students are to be listed.

If the course is amenable to technologically mediated forms of delivery please identify how the integrity of learning evaluation will be maintained. (e.g. will "on-site" examinations be required, etc.)

Activity Grade: 30%

This will include clicker activities, think-pair-share, pop-talks, hands-on activities in support of the projects (described below), and assignments in which students apply concepts from the lecture materials and selected reading materials to explore problem-solving methods used by scientists in the search for life. These activities will be completed either in-person or online, depending on the course delivery format (described above in Course Design).

Project 1: 10%

Landing Party: Students will apply the scientific method to the search for life by exploring different environments around campus or their home as if they were aliens visiting Earth for the first time. A "Mission Report" will be submitted that lists what observations they made, lists what conclusions they can make about the lifeforms that inhabit Earth, and answers reflection questions. Students will also be asked to take "samples" from the environments for Project 2.

Project 2: 10%

Spectroscopy Lab: Students will learn spectroscopic methods used in the search for life. Using freely available smart phone camera apps that provide measurements of the amount of red, blue, and green light in an image, students will measure the absorption spectrum of different liquids and the reflectance spectrum of different biological and non-biological samples from their Landing Party project.

Project 3: 10%

First Contact: Students will learn about the search for life using radio signals and strategies for constraining the origin and nature of a signal's extraterrestrial sender. Operating as if human beings have received a possible signal from an intelligent alien species, students will work with synthetic observations of three planetary systems in order to determine which system is most likely to be the source of the signal in order for humans to send a signal back. Given their findings, students will also speculate about the biology of the lifeforms that sent the signal.

Midterm: 15% (will include multiple choice, problem-solving, and short answer questions based on lecture and reading materials)

Final Exam (in exam period): 25% (will include multiple choice, problem-solving, and short answer questions based on lecture and reading materials)

Bibliography:

A READING LIST MUST BE INCLUDED FOR ALL NEW COURSES

The Library has requested that the reading list contain complete bibliographical information, such as full name of author, title, year of publication, etc., and that you distinguish between required and suggested readings. A statement is required from the bibliographer responsible for the discipline to indicate whether resources are adequate to support the course.

Also please list any online resources.

If the course is to be integrated (graduate/ undergraduate), a list of the additional readings to be required of graduate students must be included. If no additional readings are to be required, a rationale should be supplied.

LIBRARY SUPPORT STATEMENT MUST BE INCLUDED.

Internal:

The below textbooks, along with select scientific papers, will be used for generating the majority of the course content.

- Brinckmann, Enno 2007 "Biology in Space and Life on Earth: Effects of Spaceflight on Biological Systems", Wiley-VCH
- Clement, Filles & Slenzka, Klaus 2006 “Fundamentals of Space Biology: Research on Cells, Animals, and Plants in Space”, Microcosm Press Springer
- Cockell, Charles S. 2015, "Astrobiology: Understanding Life in the Universe", Wiley-Blackwell
- Nechitailo, Galina & Kondyurin Alexey 2021, “Biological Experiments in Space”, Elsevier
- Rothery, David A., Gilmour, Iain, and Sephton, Mark A. 2004, “An Introduction to Astrobiology”, Cambridge University Press

Required Student Reading:

Students will occasionally be assigned recent news articles and popular science publications on topics pertaining to astrobiology in order to participate in pop talks and think-pair-share activities. These articles are available online at no cost to students. Examples of such readings include:

- Maggie, F. & Pallud, C. 2010 “Martian base agriculture: The effect of low gravity on water flow, nutrient cycles, and microbial biomass”, Advances in Space Research, 46, 10
- Kittan Jost, A., Hoson, T., & Iverson T. 2015, “The Utilization of Plant Facilities on the Internation Space Station – The Composition, Growth, and Development of Plant Cell Walls under Microgravity Conditions”, Planet, 4, 44
- Wetzel, H., “A Novel Approach To Growing Gardens in Space”, NASA’s eXposed Root On-Orbit Test Systems Project, https://science.nasa.gov/technology/technology-highlights/a-novel-approach-to-growing-gardens-in-space
- Weronika, E. & Lukasz, K. 2017, “Tardigrades in Space Research – Past and Future”, Origins of Life and Evolution of Biospheres 47, 545-553
- JWST Transiting Exoplanet Community Early Release Science Team 2023, “Identification of Carbon Dioxide in an Exoplanet Atmosphere”, Nature, 614, 649

Optional Student Reading:
While there is no required textbook for the course, students may prefer to have supplementary sources to aid in their understanding of course concepts. For select topics, I will refer students to the appropriate sections in the freely available openstax astronomy and biology textbooks; eg,

- From Astronomy-2e (https://openstax.org/details/books/astronomy-2e), Chapters 5 (Radiation and Spectra), 8 (Earth as a Planet), 10 (Earthlike Planets: Venus and Mars), 12 (Rings, Moon, and Pluto), 21 (Birth of Stars and the Discovery of Planets outside the Solar System), and 30 (Life in the Universe) are all connected to the themes outlined in the Expanded Course Description.

- From Biology 2e (https://openstax.org/details/books/biology-2e), Chapters 1 (The Study of Life), 2 (The Chemical Foundation of Life) , 3 (Biological Macromolecules), and 8 (Photosynthesis) are all connected to the themes outlined in the Expanded Course Description.

Other Resources:

A statement regarding the adequacy of physical resources (equipment, space, etc.) must be appended. If other resources will be required to mount this course, please explain

COURSES WILL NOT BE APPROVED UNLESS IT IS CLEAR THAT ADEQUATE RESOURCES ARE AVAILABLE TO SUPPORT IT.

In the LECT and BLEN formats, this course will require the regular lecture hall facilities (with standard York University lecture hall IT equipment): classroom space for 150-200 as well as access to an eClass course.

Teaching assistants (T3) will be needed to assist with marking the activities and homework assignments, projects, the midterm, and the final exam.

Course Rationale:

The following points should be addressed in the rationale:

How the course contributes to the learning objectives of the program / degree.

The relationship of the proposed course to other existing offerings, particularly in terms of overlap in objectives and/or content.

If inter-Faculty overlap exists, some indication of consultation with the Faculty affected should be given.

The expected enrolment in the course.

Contribution to Program Learning Objectives

As stated in the document "What is a NATS Course?" developed by the Division of Natural Science, the primary goal of a NATS course is to develop students' scientific literacy and critical thinking in a scientific context. To this end, NATS courses aim to achieve the following:

- broaden student horizons ("**breadth**")
- expose students to some of the fundamental ideas of the course's major discipline ("**scientific knowledge**")
- promote multi- or interdisciplinarity ("**multi/interdisciplinarity**")
- develop skills, problem-solving tools and assessment strategies, some of which are specific to the course's discipline ("**critical skills**" and "**critical thinking**")

The field of astrobiology is truly **interdisciplinary**, as students will develop scientific literacy in the context of both biology and astronomy. As stated in the course's learning outcomes, students will acquire working **scientific knowledge** of fundamental topics in the field of astrobiology, thereby expanding the **breadth** of a non-science major in any discipline.

The course projects are designed with experiential learning in mind, where students are physically going out to collect their own data and performing their own analysis on the data. This approach, in addition to the active-learning activities and homework assignments, will provide opportunities for students to develop their **critical skills** and **critical thinking** while learning new problem-solving tools.

Relationship of the Course to Program Offerings

Over the past two decades, significant advancements in the field of astrobiology have led to an increase in the popularity of NATS1880 Life Beyond Earth and expressions of interest for more courses in this exciting field. As such, NATS has recently hired a faculty member (Jeremy Webb) for the purpose of developing its astrobiology course offerings.

At present, NATS1880 6.0 is offered twice per year, but as students typically choose their NATS courses after scheduling the courses required for their major, a 6-credit in-person NATS course can be difficult for students to fit in their schedules. Meanwhile, the popular 3-credit course NATS1570 Exploring the Solar System is offered 2-3 times per year, but NATS1570 students who want to delve further into the search for life in our Solar System do not have another 3-credit option in this area to complete their required 6 NATS credits. Similarly, NATS1530 3.0 The Science of Space Flight is offered 2-3 times per year, but students who want to learn more about human space exploration do not have a 3-credit option. Thus, NATS1572 is one of two new 3-credit courses being proposed for 2024 and 2025, the other (NATS1532) being a course pertaining to the human presence in space. Once these courses are developed, it is anticipated that NATS will offer NATS1880 once per year in addition to NATS1530 and NATS1570 in the fall and NATS1532 and NATS1572 in the winter, with the option of offering one or more of the 3-credit courses in the summer term based on popularity. This suite of courses will provide more options and greater flexibility for students who want to complete all of their NATS credits in this fascinating area.

Faculty and Department Approval for Cross-listings:

If the course is to be cross-listed with another department, this section needs to be signed by all parties. In some cases there may be more than two signatures required (i.e. Mathematics, Women's Studies). In the majority of the cases either the Undergraduate Director or Chair of a unit approves the agreement to cross-list. All relevant signatures must be obtained prior to submission to the Faculty curriculum committee.

Dept:	_____	_____	_____
	Signature (Authorizing cross-listing)	Department	Date
Dept:	_____	_____	_____
	Signature (Authorizing cross-listing)	Department	Date
Dept:	_____	_____	_____
	Signature (Authorizing cross-listing)	Department	Date

Accessible format can be provided upon request.

MEMORANDUM

York University Libraries

To: Robin Metcalfe

From: William Denton

Date: 13 July 2023

Subject: Library Statement of Support – NATS 1572 (Introduction to Astrobiology)

Summary

York University Libraries (YUL) is well positioned to support the proposed course. Faculty and students can make use of an array of library resources and services to meet their research and learning needs.

Collections

The Libraries' collections echo the curricular and research priorities of students and faculty. Care is given to select materials that reflect new courses taught at York, as well as research and publishing trends. Library personnel review reading lists supplied for proposed courses to address any potential gaps.

Historically, textbook publishers have not made their electronic content available for purchase by libraries. This remains an ongoing challenge, and Cockell's *Astrobiology: Understanding Life in the Universe* is not available to us. Of the other books listed in the proposal, we already own all but one, and I have ordered the one we didn't. I applaud the use of open educational resources for supplementary readings. (On that topic, the Libraries' Open Scholarship department offers support to researchers on digital publishing, open repositories, and Creative Commons licensing.)

The Omni single-search interface provides students with access to a wide range of materials, including books, book chapters, articles, dissertations, streaming media, etc. Library users may also request items from partner libraries through Omni. The A-Z list on the Libraries' website provides a complete register of electronic offerings.

There is a rich variety of material available to support this interesting interdisciplinary first-year course.

Services

Library Instruction

Librarians and archivists help students build research skills and digital fluencies through workshops, online research guides, and individual research assistance. Instructors can arrange a research skills workshop (or seminar) geared to a specific assignment, course, or competency.

Research Guides of Interest:

- Astronomy
- Biology
- Ecology

Research Help

Online research assistance is available in both English and French via chat and email. In addition, students and faculty can book one-hour research consultations with a specialist librarian.

Accessibility Services

Library Accessibility Services (LAS) provides alternative content formats, as well as adaptive technologies and spaces. With a referral, York University faculty and students can request transcription services or reserve an accessibility lab workstation. Contact lashelp@yorku.ca with questions.

COMMITTEE ON ACADEMIC STANDARDS, CURRICULUM AND PEDAGOGY TEMPLATE

NEW COURSE PROPOSAL FORM

Faculty: Indicate all relevant Faculty(ies)	Science
Department: Indicate department and course prefix (e.g. Languages, GER)	Division of Natural Science, Department of Science and Technology Studies
Date of Submission:	June 2023
Course Number: Special Topics courses Include variance (e.g. HUMA 3000C 6.0, Variance is "C")	NATS 1506
Var:	
Academic Credit Weight: Indicate both the fee, and MTCU weight if different from academic weight (e.g. AC=6, FEE=8, MET=6	3.0
Course Title: The official name of the course as it will appear in the Undergraduate Calendar and on the Repository	Understanding Artificial Intelligence
Short Title: Appears on any documents where space is limited - e.g. transcripts and lecture schedules - **maximum 40 characters**	Understanding Artificial Intelligence

Commented [RM1]: Name change is broader. Also ties the course to NATS1505 Understanding Cyberspace, highlighting the two courses as an option for students wanting to complete their 6 NATS credits in the tech area.

With every new course proposal it is the Department's responsibility to ensure that new courses do not overlap with existing courses in other units. If similarities exist, consultation with the respective departments is necessary to determine degree credit exclusions and/or cross-listed courses.

Brief Course Description:

Maximum 2000 characters *(approximately 300 words including spaces and punctuation).*
The course description should be carefully written to convey what the course is about. It should be followed by a statement of prerequisites and co-requisites, if applicable. This description appears in the calendar.
For editorial consistency, and in consideration of the various uses of the Calendars, verbs should be in the present tense (i.e., "This course analyzes the nature and extent of...," rather than "This course will analyze...")

Artificial Intelligence (AI) is everywhere. It is increasingly responsible for 'putting the smarts' into our everyday lives - literally, into the palm of our hand with mobile devices. It is delivering outcomes of tremendous value to people - for example, by enabling scientists to rapidly transform data into information and then information into knowledge. Furthermore, as we as a species collectively address the challenges inherent in climate and global change, AI is being applied to improve prospects for regional to planetary-scale ecosystems.

However, AI has its challenges. To provide an informed and balanced perspective on the value of AI as a problem-solving tool, this course introduces students to the essence of AI that allows deep neural networks to implement algorithms that are applied to data. By drawing upon a broad array of applications of AI to the life and physical sciences and making hands-on use of AI tools, past and present applications of AI can be understood at a new level of literacy. With this newfound literacy, AI-mediated prospects for future use can be critically assessed.

Students do not require a background in science or math beyond the Grade 12 level to be successful in this course.

Pre/Co-requisites: None.
CCEs: None
NCR: Not open to any student who has successfully taken or is taking AP/ITEC4310 3.00, LE/EECS 3401 3.00 or LE/EECS 4401 3.00.

Commented [RM2]: This section has been made more concise and a few ambiguous statements have been clarified.

Commented [RM3]: NCRs have been revised as per recommendations by FSc Curriculum

Generic Course Description:
This is the description of the "Parent / Generic course" for Special Topics courses under which variances of the "Generic" course can be offered in different years (Max. 40 words). Generic course descriptions are published in the calendar. List all degree credit exclusions, prerequisites, integrated courses, and notes below the course description.

This interdisciplinary course introduces students to applications of Artificial Intelligence (AI) as a tool for solving problems in the life and physical sciences. To provide an informed and balanced perspective on the value of AI, the course exposes the essence of AI that allows deep neural networks to implement algorithms that are applied to data. By making hands-on use of AI, past and present applications of AI can be understood at a new level of literacy. With this newfound literacy, AI-mediated prospects for future use can be critically assessed.

Pre/Co-requisites: None.
CCEs: None
NCR: Not open to any student who has successfully taken or is taking AP/ITEC4310 3.00, LE/EECS 3401 3.00 or LE/EECS 4401 3.00.

Expanded Course Description:
Please provide a detailed course description, including topics / theories and learning objectives, as it will appear in supplemental calendars.

Course Learning Outcomes

Upon successful completion of the course students should be able to:

a) Describe the gap between reality and popular perceptions of AI
b) Explain selective aspects of the life (e.g., genomics) and physical sciences (e.g., weather prediction and climate scenarios) from a scientifically literate perspective.
c) Explain selective aspects of AI (eg., Machine Learning, Deep Learning, Transformers) from a perspective literate of computer science.
d) Describe and critically assess present and future applications of AI as a problem-solving tool in the life and physical sciences, via the systematic progression from data to information, and information into knowledge.
e) Demonstrate the application of various skills (e.g., problem solving, interpreting algorithms, critical thinking, inferencing, reasoning, communication and geospatial skills) involved in articulating various uses of AI in the natural sciences.

Commented [RM4]: Added for more comprehensive mapping with the course topics

Commented [RM5]: In points (b) and (c), the immeasurable verb 'Understand' has been replaced with Explain.

Commented [RM6]: Minor changes to make this more concise

Course Topics

Part 0 - Prelude

Science Fiction - Vision (~ 1 week)
Purpose: To glean a perspective for 21st-century AI from the most-influential science fiction writers of the last century.

- A brief survey of the science-fiction literature that highlights the works of the most-influential writers of the 20th century - e.g., (and listed here alphabetically), Issac Asimov, Ray Bradbury, Arthur C. Clarke, Philip K. Dick, Robert A. Heinlein, and Stanisław Lem.
- *Activities:* From directed readings and recordings to visuals (art, images, films, videos) of key passages/moments to AI-generated summaries of an author's corpus of work, an initial framing of the adage "today's science fiction is tomorrow's science fact" will be made. Specific activities include,

for example, a critical assessment of the relevance of Asimov's Three Laws of Robotics within the context of AI today.

To be able to critically assess current and future prospects for AI applications in the natural sciences, this course begins with a survey of problem-solving tools in mathematics, natural science, and AI, examined independently prior to their present and future convergence.

Part 1 - Past

Note: Care will be taken to judiciously (re-)introduce mathematics only as required by the course's learning outcomes - e.g., to uplevel students' mathematics literacy with respect to AI for problem solving in the natural sciences. As this is not a mathematics course, success will only depend upon students grasping the gist of mathematical concepts. The same expectations apply to the physical and Life Sciences as representations of natural sciences. In all cases, efforts will be made to begin with and (as much as possible) 'lean on' the familiar and systematically transition to the more involved with adequate scaffolding to facilitate the learning process.

Mathematics - Background (~ 1 week)
Purpose: To re-introduce just enough mathematics to allow students to appreciate problem solving from a qualitative and quantitative basis independent of AI.

- Review of examples from high-school mathematics that illustrate problem solving by following a prescribed sequence of steps (essentially, an algorithm).
- Introduction to numerical methods as a means for solving mathematical problems via a computational algorithm.
- *Activities*: An example of a simple analytic mathematical and numerical method as an algorithm. Scaffolded expressions from plain language to pseudocode (i.e., a simplified programming language). 'Programming the algorithm' via AI (e.g., by making use of ChatGPT, GitHub Copilot, or similar). [Note: Students in this course are not expected to be programmers in the computer-science sense; the objective here is to appreciate the flow from problem solving to algorithm to code to results.]

Natural Science - Background (~ 0.5 weeks)
Purpose: To introduce an appreciation for the traditional means of solving scientific problems.

- Introduction to the scientific method.
- Introduction to scientific models and simulations.
- A conceptual introduction to epidemiological models.
- Introduction to informatics as a means for problem solving.
- Examples may include: climate models, the SEIR compartmentalized model used during the COVID-19 pandemic, DNA-sequence use in genetics, etc.

Commented [RM7]: Parts 1, 2 and 3 have been made more concise, emphasizing the relevant theme of each topic.

Commented [RM8]: This section has been clarified

Commented [RM9]: Note: 0.5 weeks = one 90min lecture.

- *Activities*: Develop concept sketches to capture interacting systems. Explore epidemiological and/or weather/climate scenarios with pre-built demonstrations. A facilitated run through of genomics sequence analysis. (Note: The instructor is generalizing use of concept sketches for use here from geoscience courses.)

Artificial Intelligence - Background (1.5 weeks)
Purpose: To provide a selective overview of AI prior *to Deep Learning (i.e., prior to circa 2011).*

- An introduction to AI as originally framed circa 1956 and a discussion of the breadth and depth of the AI landscape.
- Establishing the gap between the scientific reality of AI at this time and the vision portrayed through 20th-century science fiction.
- Introduction to Machine Learning (aka. ML, and as a subset of AI)
- Introduction of neural networks, the Turing test.
- AI's successes and failures - including the need to 'weather' two 'AI winters.'
- *Activities*: Labeling data for supervised learning. Can Alexa/Cortana/GoogleAssistant/Siri/etc. pass the Turing test? How about ChatGPT/Google Bard/etc.? Gamification as an immersive means for 'experiencing' an algorithm. High-level pseudocode for a Machine Learning algorithm. 'Implementation' of a Machine-Learning algorithm via ChatGPT, GitHub Copilot, or similar. [Note: Students in this course are not expected to be programmers in the computer-science sense; the objective here is to appreciate the flow from problem solving to algorithm to code to solution. Numerous AI platforms offer no or low-code interfaces for those who aren't developers.]

Part 1 Summary
Purpose: To draw together the three strands of mathematics, natural science, and AI, and extract the salient outcomes required for the remainder of the course.

Part 2 - Present

Note: Students are not expected to be scientists. There is no requirement to code/program, engage deeply in mathematics nor the physical or Life Sciences. Topics will be scaffolded to ensure students have the required background to appreciate outcomes delivered by AI.

Artificial Intelligence - 'Recent' History (~ 1.5 weeks)
Purpose: To provide a selective overview of AI during and after the advent of Deep Learning (i.e., around and after circa 2011).

- Deep Learning within the context of AI and Machine Learning. Definition of Deep Learning - what makes it DEEP, how it is similar to/different from Machine Learning.

- Introducing deep neural networks.
- The emergence of Deep Learning - from the combination of Big Data, compute-intensive processing, and algorithms.
- The proliferation of processors for Deep Learning (aka. the 'processor zoo').
- Introduction of Transformers - attention-based deep neural networks.
- The intersection of AI and 'edge computing'.
- AI in mobile devices.
- An overview of the programming landscape for Deep Learning.
- The Transformer (aka. Generative AI) revolution.
- *Activities: Pseudocode for classifying cats vs. dogs. Supervised versus unsupervised learning. Applications of LLMs in the natural sciences (e.g., ChatGPT/Google Bard/etc. as the 'teacher'). Intersections of LLMs with computer vision (e.g., scientific illustrations via DALL·E 2). Tactics and strategies for tracking progress in AI - what to read?, what to listen to?, what to watch?*

AI Applications - Life Sciences (~ 1.5 weeks)
Purpose: To survey contributions of AI to problem solving in the Life Sciences.

- Deep Learning by example: medical imagery. From Röntgen's X-Rays to 'replacing' radiologists by algorithms for object detection and classification. Detailed example involving classification via decision trees. Extracting details within objects via image segmentation.
- Overview of AI's contributions towards the COVID-19 pandemic - spanning population health, vaccine development (including gene splicing), and viral mutations.
- Applications of Transformer-based architectures for Deep Learning in the Life Sciences - from genomics-as-a-language to parsing reams of situational content (e.g., medical, demographic, social, ...).
- Foreshadowing the need for scientifically responsible AI - e.g., the ethical dilemmas associated with genetic modifications.
- *Activities: Pseudocode for classifying objects in medical images. Use of a pre-built implementation for image classification and segmentation. Enhancing classical epidemiological models via Deep Learning. An overview of the development of vaccines for COVID-19. Informatics perspective of genetic mutations (e.g., virus variants, genotypes) via the application of large language models.*

AI Applications - Physical Sciences (~1 week)
Purpose: To survey contributions of AI to problem solving in the Physical Sciences. [Combined with the Life Sciences applications above, the purpose here is to survey a variety of methods for Machine and/or Deep Learning.]

- Classical means for numerical weather prediction (NWP) - an overview of the Grand Challenge of mathematical physics.

- Discovering mathematics from observations - the emergence of 'GoPro physics.'
- Applying the Transformer architecture to weather - e.g., predicting hurricane paths with just AI.
- Classical means for modeling and simulating potential climate scenarios. AI-mediated approaches for climate - from automated parameter studies (e.g., filling-in and fleshing-out ensembles of simulations) to real-time Digital Twins.
- *Activities: GoPro physics in action. NWP (e.g., hurricanes) and climate scenarios - from toy examples (e.g., the Energy Balance Climate Model, EBCM) to pre-built models and simulations. Extracting scientific data from Twitter, Instagram, etc.*

Challenges and Opportunities of AI (~1 week)

Commented [RM10]: Increased from 0.5 weeks

Purpose: To reflect on the value AI currently delivers as well as the challenges currently faced.

- Sustainability - the computational cost of AI.
- Explainability - making sense of the output from AI-based models.
- Bias resulting from model training
- Ethics - confronting the ethical dilemmas that emerge when making use of AI
- Constraints and limitations of AI.
- Creativity - does creativity remain a pursuit unique to humans?
- Learning-specific topics - e.g., academic integrity, assessment.
- The notion of scientifically responsible AI.
- *Activities: Landslide susceptibility as a case study in explainability. Estimating the Carbon footprint of AI. Understanding the context for responsible AI in science. Critical thinking via essays, presentations. Introducing 'litmus tests' for the magic of AI.*

Part 2 Summary

Purpose: To draw together the three strands of mathematics, natural science, and AI, and extract the salient outcomes required for the remainder of the course.

Part 3 - Future

Artificial Intelligence - Emerging and Future Prospects in the Natural Sciences (~ 2 weeks)

Purpose: To survey the breadth and depth of prospects for problem solving in the natural sciences via AI - from those that are currently emerging to those that are speculative at best.

- Examples of when AI *independently* produces novel and useful scientific results via independent application of the scientific method.
- Emerging prospects for AI in the life and physical sciences - - anticipating results achievable with incremental to revolutionary gains in AI.

- Future prospects for AI based on the book *AI 2041* - a compilation for approximately 20 years hence.
- A brief survey of 'contemporary' science fiction literature that highlights the works of the most-influential writers of the late 20th and 21st century - e.g., (and listed here alphabetically), Douglas Adams, William Gibson, Neal Stephenson, ...
- Towards Artificial General Intelligence (AGI) - are we there yet?
- *Activities: Appreciating emerging prospects - e.g., by immersing in prospective scenarios (e.g., via gamification). An AI-independent scientific method? Evaluating future prospects - e.g., appreciation and sample application of the tactics and strategies employed by the most-influential futurists. Key takeaways from contemporary SCIFI authors.*

Course Design:
Indicate how the course design supports students in achieving the learning objectives. For example, in the absence of scheduled contact hours what role does student-to-student and/or student-to-instructor communication play, and how is it encouraged?
Detail any aspects of the content, delivery, or learning goals that involve "face-to-face" communication, non-campus attendance or experiential education components.
Alternatively, explain how the course design encourages student engagement and supports student learning in the absence of substantial on-campus attendance.

This course is designed to be delivered either in-person (LECT) or online with in-person exams (ONCA). It will consist of three lecture hours per week for a total of 36 hours (3.0). It can be offered at any time of the year - i.e., in the Fall, Winter, and/or Summer terms.

Lectures will introduce students to the course material outlined in the "Expanded Course Description" section above. To ensure lectures are active-learning experiences, various strategies are used - e.g., interactive responses (e.g., iClicker questions), concept sketching (see references), facilitated (mini) discussions (e.g., think-write-pair-share), and follow-up quizzes. For the ONCA format, synchronous (optional) and asynchronous discussions will be facilitated via group work involving use of various technologies - e.g., Zoom break-out rooms, eClass discussion forums, Kritik (see below), ... Overall, the technologies employed in the ONCA format ensure that aspects of the in-class experience (e.g., think-write-pair-share) can be delivered online. The assessment scheme thus incorporates a participation component in both the LECT and ONCA formats.

As labs are mediated as "activities" via the Kritk platform for peer interaction, the learning process is *extended* to include evaluation and feedback. In addition to positive learning outcomes, as qualified via Bloom's revised taxonomy, for example, peer interaction is known to have other positive outcomes - e.g., with respect to student wellbeing. (Refer to references for additional details.)

Assignments are employed to complement labs.

Experiential Education: As students will observe and even interact with real-world plus virtual AI and related technologies (e.g., ChatGPT or similar, immersive gaming, the emerging metaverse), this course has an element of experiential education (EE). Aspects of this engagement may involve independent, out-of-the-classroom experiences. For example, students may be directed on a 'scavenger hunt' that requires them to obtain pictures of real-world objects (e.g., clouds, streams, a test tube) with their smartphone, listen to music from an unknown genre; subsequently, using AI-based technologies (e.g., Google Lens on their smartphone), make sense of their experiences (e.g., automatically classify a cloud according to its type or the flow in a stream as laminar or turbulent, plus the genre, artist, and name of an audio recording). As another example, in-person or virtual watching parties (e.g., via Youtube, Netflix or similar streaming services)

will allow students to interact a/synchronously in groups as they experience, for example, a classic (e.g., 2001: A Space Odyssey, Bladerunner, Fahrenheit 451) or contemporary SCIFI movie, an online lecture (e.g., Gil Strang's Final 18.06 Linear Algebra Lecture), etc.

Instruction:

1. Planned frequency of offering and number of sections anticipated (every year, alternate years, etc.).
2. Number of department members currently competent to teach the course.
3. Instructor(s) likely to teach the course in the coming year.
4. An indication of the number of contact hours (defined in terms of hours, weeks, etc.) involved, in order to indicate whether an effective length of term is being maintained **OR** in the absence of scheduled contact hours a detailed breakdown of the estimated time students are likely to spend engaged in learning activities required by the course.

1. 1-2 sections will be offered in F, W, SU, S1 or S2. The ONCA format would be reserved for the summer term and the LECT format for F or W.
2. This course could be taught by faculty members with an expertise in the application of AI in the natural sciences. At present, there is one faculty member in STS/NATS with the expertise required to teach this course. (The course does not need to be offered annually if this faculty member is unavailable).
3. Ian Lumb is expected to teach the initial offering of this course.
4. This course will consist of 3 lecture hours per week for a total of 36 hours (3.0).

Commented [RM11]: Correction: Replaced ONLN with LECT.

Evaluation:

A detailed percentage breakdown of the basis of evaluation in the proposed course must be provided.
If the course is to be integrated, the additional requirements for graduate students are to be listed.
If the course is amenable to technologically mediated forms of delivery please identify how the integrity of learning evaluation will be maintained. (e.g. will "on-site" examinations be required, etc.)

The proposed evaluation scheme for this course is as follows:

- Lecture - in-class participation (optional) 5% or 0%
- Post-lecture - questions 10%
- Assignments (2, 6% each) 12%
- Labs (aka. Kritik Activities, 3, 6% each) 18%
- Project 30%
- Final Exam 25% (with participation) or 30% (without participation)

As described above, both the LECT and ONCA format versions of the course permit **participation** via various means 'during' a lecture.

Post-lecture **questions** serve to emphasize course content. Mediated via eClass's quizzing capability, these questions will typically assume multiple-choice, True/False, matching questions. These questions are typically made available for 1-2 weeks following the lectures; during this 'availability window,' students are expected to allocate 15-30 minutes to complete this exercise. Math is explicitly excluded from this course component.

Both **labs** and **assignments** place emphasis on engaging in course content by focusing on critical skills. Labs (mediated as activities via the Kritik platform for peer interaction) are employed primarily as the means for Experiential Education (e.g., the scavenger hunt alluded to above). Assignments require a narrower and

Commented [RM12]: Project weight has been increased. Project is described below.

deeper use of skills in support of engaging in course content. Assignments would be the component that would, for example, require students to engage in the progress from a mathematical concept (e.g., root finding) to an algorithm (e.g., pseudocode) to implemented code (e.g., via an AI copilot). Assignments will be assessed by the instructor and/or teaching assistants assigned to the course. Refer to the "Activities" sections in the "Expanded Course Description" for potential lab and/or assignment topics.

Within the first week or two of the course, students are asked to identify an AI-based technology/service/solution/product (e.g., a dancing robot, ChatGPT, Siri, the HAL 9000, image or video art, ...) that fascinates them for a project. Then, as the course progresses, students are expected to progressively tease out the AI (e.g., computer vision, Natural Language Processing, ...) that underpins the technology/service/solution/product they selected. Using any means available to them (e.g., analogies, gamification, videos, ...), students are expected to convey the gist of a key AI algorithm involved in the delivery of the technology/service/solution/product they selected. With the AI demystified from magic, students will share their findings with their peers in the class (either in person or online via Kritik). To close out this project, students will be expected to apply critical thinking skills to the technology/service/solution/product they selected to assess it through the lens of responsible AI. Finally, students will be guided through a personal reflection that spans the duration of the project.

It is important to note that students are only required to 'do math' when they choose to (because there exists choice on the exams) or when they can be supported (e.g., on labs and/or assignments when they can collaborate with their peers and/or seek assistance from the instructor/TAs).

Bibliography:
A READING LIST MUST BE INCLUDED FOR ALL NEW COURSES
The Library has requested that the reading list contain complete bibliographical information, such as full name of author, title, year of publication, etc., and that you distinguish between required and suggested readings. A statement is required from the bibliographer responsible for the discipline to indicate whether resources are adequate to support the course.
Also please list any online resources.
If the course is to be integrated (graduate/ undergraduate), a list of

There is no assigned textbook for this course as an appropriate text does not exist owing to the topic being a *rapidly* evolving area.

Assigned readings in the form of scientific and mainstream media articles (e.g., newspapers, magazines, blogs, podcasts, videos, …) will be made available to students as needed, and will vary to complement specific topics and to examine current issues/events/etc. (e.g., our evolving response to the ongoing COVID-19 pandemic). Students will have access to lecture slides/notes for study purposes.

Course resources may include:

[Note: Most of these resources are already available online via the public Internet or via York University's libraries (YULs). For required resources, additional arrangements may be deemed necessary and result in access via YULs and/or the York University Bookstore (e.g., via a course kit).]

Armstrong, P. (2010). Bloom's Taxonomy. Vanderbilt University Center for Teaching. Retrieved October 26, 2022 from https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/.

the additional readings to be required of graduate students must be included. If no additional readings are to be required, a rationale should be supplied. **LIBRARY SUPPORT STATEMENT MUST BE INCLUDED.**

Bauer, P., Thorpe, A. & Brunet, G. The quiet revolution of numerical weather prediction. Nature 525, 47–55 (2015).

Bengio, Y., Courville, A., & Vincent, P. (2013). Representation learning: A review and new perspectives. IEEE transactions on pattern analysis and machine intelligence, 35(8), 1798-1828.

Benjamin, R. (2019). Race after technology: Abolitionist tools for the new Jim code. Polity.

Bi, K., Xie, L., Zhang, H. et al. Accurate medium-range global weather forecasting with 3D neural networks. Nature (2023). https://doi.org/10.1038/s41586-023-06185-3

Bogoch et al., Pneumonia of unknown aetiology in Wuhan, China: potential for international spread via commercial air travel, Journal of Travel Medicine, 2020, https://doi.org/10.1093/jtm/taaa008.

Brown, P. C., Roediger III, H. L., & McDaniel, M. A. (2014). *Make it stick: The science of successful learning.* Harvard University Press.

Criminisi, A. (2016). Machine learning for medical images analysis. Medical Image Analysis, 33, 91-93.

Gent, E. (2021). Can Earth's Digital Twins Help Us Navigate the Climate Crisis? IEEE Spectrum. https://spectrum.ieee.org/climate-models.

Gentner, D., Brem, S., Ferguson, R. W., Markman, A. B., Levidow, B. B., Wolff, P., & Forbus, K. D. (1997). Analogical reasoning and conceptual change: A case study of Johannes Kepler. The journal of the learning sciences, 6(1), 3-40.

Georgescu, J. (2022). How machines could teach physicists new scientific concepts | Nature Reviews Physics.

Gleick, J. (2011). The information: A history, a theory, a flood. Vintage.

Hanson, J. M., Trolian, T. L., Paulsen, M. B., & Pascarella, E. T. (2016). Evaluating the influence of peer learning on psychological well-being. *Teaching in Higher Education,* 21(2), 191-206.

Isaacson, W. (2021). The code breaker: Jennifer Doudna, gene editing, and the future of the human race. Simon and Schuster.

Commented [RM13]: Additional resource

Ivanova, A. (2023). Does ChatGPT "Think"? A Cognitive Neuroscience Perspective with Anna Ivanova, The TWIML AI Podcast, https://twimlai.com/podcast/twimlai/does-chatgpt-think-a-cognitive-neuroscience-perspective/.

O'Neil, C. (2017). Weapons of math destruction. Penguin Books.

Noble, S. U. (2018). Algorithms of oppression: How search engines reinforce racism. New York University Press.

Polya G. How to solve it: A new aspect of mathematical method. Princeton University Press; 2004.

Shailee Jain, Vy A. Vo, Leila Wehbe, Alexander G. Huth; Computational Language Modeling and the Promise of in Silico Experimentation. Neurobiology of Language 2023; doi: https://doi.org/10.1162/nol_a_00101

Johnson, J. K., & Reynolds, S. J. (2005). Concept sketches—Using student-and instructor-generated, annotated sketches for learning, teaching, and assessment in geology courses. Journal of Geoscience Education, 53(1), 85-95.

Kermack, W. O., & McKendrick, A. G. (1927). A contribution to the mathematical theory of epidemics. Proceedings of the royal society of london. Series A, Containing papers of a mathematical and physical character, 115(772), 700-721. https://doi.org/10.1016/j.mbs.2005.07.006

Krathwohl, D.R. (2002). A Revision of Bloom's Taxonomy: An Overview, Theory into Practice, Vol. 41, No. 4, Revising Bloom's Taxonomy (Autumn, 2002), pp.212-218, Ltd.Stable URL: http://www.jstor.org/stable/1477405.

Kurzweil, R. (2005). The singularity is near: When humans transcend biology. Penguin.

LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. Nature, 521(7553), 436-444.

Li D. Cognitive Physics—The Enlightenment by Schrödinger, Turing, Wiener and Beyond. *Intell. Comput.* 2023;2: Article 0009. https://doi.org/10.34133/icomputing.0009

Lumb, I. (2003). production HPC reinvented. ; login:: the magazine of USENIX & SAGE, 28(4), 15-22. https://www.usenix.org/system/files/login/articles/1182-lumb.pdf

Commented [RM14]: Additional resources

Lumb, I. (2017). Nurturing Quantitative Skills for the Physical Sciences through use of Scientific Models, The World Conference on Online Learning: Teaching in The Digital Age – Re-Thinking Teaching & Learning, October 16-19, 2017, Toronto, Canada. [Introduction of EBCM beyond York University.]

Lumb, I. (2018). Towards Tsunami Informatics: Applying Machine Learning to Data Extracted from Twitter. https://ianlumb.blog/2018/10/02/towards-tsunami-informatics-applying-machine-learning-to-data-extracted-from-twitter/

Lumb, I. Using Experiential Education to Bootstrap Geoscientific Thinking and Learning in Natural Science Courses, Teaching in Focus Conference (TiF 2021), May 10-11, 2021. https://event.fourwaves.com/tif2021/abstracts/0295ad82-8002-4e55-b0df-5f1821435d92

Lumb, I. Experiences with an Iterative Model for Geoscientific Thinking and Learning via Platforms for Peer-to-Peer Student Interaction, Teaching in Focus Conference (TiF 2022), May 11-12, 2022. https://event.fourwaves.com/tif2022/abstracts/3915f0c6-5e4b-4a23-a875-c9bcbe776933

Lumb, L. I. (2022). Peer-facilitated interleaving using the four geoscientific perspectives: prospects for competency-based measures of learning at the undergraduate level. AGU Fall Meeting 2022, Chicago, Illinois. https://agu.confex.com/agu/fm22/meetingapp.cgi/Paper/1149805

Lumb, L. I., & Aldridge, K. D. (2005, May). Grid-enabling the Global Geodynamics Project: The introduction of an XML-based data model. In 19th International Symposium on High Performance Computing Systems and Applications (HPCS'05) (pp. 216-222). IEEE.

Lumb, L. I., & Aldridge, K. D. (2006, May). Grid-enabling the Global Geodynamics Project: automatic RDF extraction from the ESML data description and representation via GRDDL. In 20th International Symposium on High-Performance Computing in an Advanced Collaborative Environment (HPCS'06) (pp. 29-29). IEEE.

Lumb, L. I. & Aldridge, K. D. (2022). Introducing Coherent Heuristic Measures into Data-Driven Discovery: Application to Observations of Relative Paleointensity During Transitions of the Geomagnetic Field. AGU Fall Meeting 2022, Chicago, Illinois. https://agu.confex.com/agu/fm22/meetingapp.cgi/Paper/1130148

Lumb, L. I., Freemantle, J. R., Lederman, J. I., & Aldridge, K. D. (2009). Annotation modeling with formal ontologies: Implications for informal ontologies. Computers & geosciences, 35(4), 855-861.

Lumb, L. I., Lederman, J. I., Freemantle, J. R., & Aldridge, K. D. (2007, May). Semantically enabling the Global Geodynamics Project: incorporating feature-based annotations via XML Pointer Language (XPointer). In 21st International Symposium on High Performance Computing Systems and Applications (HPCS'07) (pp. 21-21). IEEE.

Mahowald et al. (2022) Google's powerful AI spotlights a human cognitive glitch: Mistaking fluent speech for fluent thought, The Conversation, https://theconversation.com/googles-powerful-ai-spotlights-a-human-cognitive-glitch-mistaking-fluent-speech-for-fluent-thought-185099

Mahowald, Kyle, et al. "Dissociating language and thought in large language models: a cognitive perspective." arXiv preprint arXiv:2301.06627 (2023). https://arxiv.org/abs/2301.06627

McCulloch, W.S., Pitts, W. A logical calculus of the ideas immanent in nervous activity. Bulletin of Mathematical Biophysics 5, 115–133 (1943). https://doi-org.ezproxy.library.yorku.ca/10.1007/BF02478259

Mukherjee, S. (2017) A.I. Versus M.D. What happens when diagnosis is automated? The New Yorker. https://www.newyorker.com/magazine/2017/04/03/ai-versus-md

Newport, C. (2023). What Kind of Mind Does ChatGPT Have? Large language models seem startlingly intelligent. But what's really happening under the hood? The New Yorker Magazine.

Prat, C.S., Madhyastha, T.M., Mottarella, M.J. et al. Relating Natural Language Aptitude to Individual Differences in Learning Programming Languages. Sci Rep 10, 3817 (2020). https://doi.org/10.1038/s41598-020-60661-8

Ravi, P. (2022). An Educator's Guide to Bloom's Taxonomy in the Classroom. https://www.kritik.ca/resources/blooms-taxonomy.

Sanmugavadivel, N. (2022). Using Bloom's Taxonomy to Enhance Academic Performance. https://www.kritik.io/resources/using-scientific-research-to-increase-academic-performance

Saravia, E. (2022). Prompt Engineering Guide. GitHub. https://github.com/dair-ai/Prompt-Engineering-Guide.

Schultz, M. G. et al. Can deep learning beat numerical weather prediction? Phil. Trans. R. Soc. A 379, 20200097 (2021).

Shimek, C. (2023) AI Outperforms Humans in Creativity Test, Neuroscience News, https://neurosciencenews.com/ai-creativity-23585/.

Strang, Gil. (2023). Gil Strang's Final 18.06 Linear Algebra Lecture, MIT OpenCourseware, https://www.youtube.com/watch?v=lUUte2o2Sn8.

Terawe Corporation, The Unfair Advantage of Informatics-Based Quantification, https://terawe.com/LifeSciences.

Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. Advances in neural information processing systems, 30.

Vollmeyer, R., & Rheinberg, F. (2005). A surprising effect of feedback on learning. *Learning and instruction,* 15(6), 589-602.

Vopson, M. M. (2019). The mass-energy-information equivalence principle. AIP Advances, 9(9), 095206.

Vopson, M. M. (2022). A possible information entropic law of genetic mutations. Applied Sciences, 12(14), 6912.

Vopson, M. M., & Robson, S. C. (2021). A new method to study genome mutations using the information entropy. Physica A: Statistical Mechanics and its Applications, 584, 126383.

Wogan, T. (2023). Algorithm produces one of the best solutions to molecules' Schrödinger equations yet. Chemistry World, https://www.chemistryworld.com/news/algorithm-produces-one-of-the-best-solutions-to-molecules-schr%C3%B6dinger-equations-yet/4016745.article.

Wheeler, J. A. (2018). Information, physics, quantum: The search for links (pp. 309-336). CRC Press.

Wood, C. (2022). Powerful 'Machine Scientists' Distill the Laws of Physics From Raw Data. Quanta Magazine. https://www.quantamagazine.org/machine-scientists-distill-the-laws-of-physics-from-raw-data-20220510/

Yang, Z., Zeng, Z., Wang, K., Wong, S. S., Liang, W., Zanin, M., ... & He, J. (2020). Modified SEIR and AI prediction of the epidemics trend of COVID-19 in China under public health interventions. Journal of thoracic disease, 12(3), 165.

Youssef, K., Shao, K., Moon, S. et al. Landslide susceptibility modeling by interpretable neural network. Commun Earth Environ 4, 162 (2023). https://doi.org/10.1038/s43247-023-00806-5

Zhuo, Terry Yue, et al. "Exploring ai ethics of chatgpt: A diagnostic analysis." arXiv preprint arXiv:2301.12867 (2023).

Other Resources:
A statement regarding the adequacy of physical resources (equipment, space, etc.) must be appended. If other resources will be required to mount this course, please explain **COURSES WILL NOT BE APPROVED UNLESS IT IS CLEAR THAT ADEQUATE RESOURCES ARE AVAILABLE TO SUPPORT IT.**

No special resources are required.

This course requires a standard lecture hall (with the typical York University lecture hall IT equipment) for 150 – 200 students. T3 (marker) TAs, as calculated via enrollment numbers are required.

As needed, use will be made of software already licensed to the University (e.g., MATLAB) or that which is subject to 'permissive' (e.g., open-source) licenses (e.g., ChatGPT, DALL·E 2, GitHub Copilot).

Course Rationale:
The following points should be addressed in the rationale: How the course contributes to the learning objectives of the program / degree. The relationship of the proposed course to other existing offerings, particularly in terms of overlap in objectives and/or content. If inter-Faculty overlap exists, some indication of consultation with the Faculty affected should be given. The expected enrolment in the course.

As stated in the document "What is a NATS Course?" developed by the Division of Natural Science, the primary goal of a NATS course is to develop students' scientific literacy and critical thinking in a scientific context. To this end, NATS courses aim to achieve the following:

- broaden student horizons ("**breadth**")
- expose students to some of the fundamental ideas of the course's major discipline ("**scientific knowledge**")
- promote multi- or interdisciplinarity ("**multi/interdisciplinarity**")
- develop skills, problem-solving tools and assessment strategies, some of which are specific to the course's discipline ("**critical skills**" and "**critical thinking**")

NATS1506 develops scientific literacy in the context of artificial intelligence as well as in various fields in the life and physical sciences. The course therefore expands the **breadth** of non-science students regardless of their major. Below, each of the course learning outcomes listed in the Expanded Course Description are abbreviated and mapped to one or more of the NATS course requirements:

a) Describe perceptions of AI vs reality (**critical thinking**)

b) Understand selective aspects of the life and physical sciences (**scientific knowledge** and **multidisciplinarity**)

c) Understand selective aspects of AI (**scientific knowledge** and **multidisciplinarity**)

d) Describe and critically assess present and future applications of AI (**critical thinking**)

e) Demonstrate the application of various skills associated with problem-solving in the natural sciences (**critical skills**)

Students typically choose their NATS course(s) after the courses required for their major have been fit into their schedule. Thus, their NATS options may be limited by their schedule, causing some students to enrol in courses which don't necessarily match their interests. To address this, the Division of Natural Science is seeking to increase its 3-credit course offerings in both in-person and online formats in order to offer students greater flexibility in obtaining their required 6 credits in NATS.

At present, there is only one 3-credit NATS course pertaining to topics in computing and information technology (NATS1505 Understanding Cyberspace). The addition of NATS1506 Understanding AI will provide an additional 3-credit option within this theme. In the past, we have offered the 6-credit course NATS1700 Computers, Information & Society in 2 concurrent sections per year. Replacing one of these sections with NATS1505 and NATS1506 provides more flexibility for students who want to complete all of their NATS credits in this area. This course will also be an attractive option as a NATS requirement for students enrolled in the tech-related programs at the Markham campus commencing Fall 2024.

There are no existing NATS or STS courses with significant overlap requiring a CCE or NCR with this course.

York currently offers

The Electrical Engineering and Computer Science program (EECS) offers some 3rd and 4th-year courses devoted to AI. Examples include LE/EECS 3401 3.00 Introduction to Artificial Intelligence and Logic Programming and LE/EECS LE/EECS 4401 3.00 Artificial Intelligence. Similarly, the School of Information Technology offers the 4th-year course AP/ITEC 4310 Applied Artificial Intelligence. These courses are intended for students pursuing a computer science major or equivalent field and are therefore greater in scope and complexity than NATS 1506. NATS 1506 is taught within a general education framework, thereby making this subject area accessible to students without a strong background in math or science. NATS1506 is therefore closed to students who have taken any of the above courses as students would have a significant academic advantage if they took NATS1506 while/after completing these courses.

Other programs at York offer courses on topics in AI pertaining to history, policy, and ethics. For example, AP/PHIL 3750 3.00 Philosophy of Artificial Intelligence, SB/OMIS 4010 3.00 Artificial Intelligence Fundamentals for

Business, LW/LAW 3592A 3.00 Legal Values: Artificial Intelligence and SC/STS 3561 3.00 From the Abacus to Artificial Intelligence: how the computer came to be. NATS 1506 is the only course that focusses on applications of AI to the natural sciences, thereby developing students' literacy in natural science in the context of this fascinating, topical and thought-provoking field.

The expected enrolment is 150-200 students.

Commented [RM15]: This section has been added to explain the purpose of emphasizing the role of AI in the natural sciences.

Faculty and Department Approval for Cross-listings:
If the course is to be cross-listed with another department, this section needs to be signed by all parties. In some cases there may be more than two signatures required (i.e. Mathematics, Women's Studies). In the majority of the cases either the Undergraduate Director or Chair of a unit approves the agreement to cross-list. All relevant signatures must be obtained prior to submission to the Faculty curriculum committee.

Dept: _____ _____ _____
Signature (Authorizing cross-listing) Department Date

Dept: _____ _____ _____
Signature (Authorizing cross-listing) Department Date

Dept: _____ _____ _____
Signature (Authorizing cross-listing) Department Date

Accessible format can be provided upon request.

Changes to Existing Course

Faculty:

Department:	Faculty of Science	**Date of Submission:**	Sept 22, 2023
Course Number:	SC/BC 3010 3.00	**Effective Session:**	Fall 2024
Course Title:	Advanced Peer Leadership		

Type of Change:

☐	in pre-requisite(s)/co-requisite(s)	☐	in cross-listing
☐	in course number/level	☐	in degree credit exclusion(s)
☐	in credit value	☐	regularize course (from Special Topics)
☐	in title (max. 40 characters for short title)	X	in course format/mode of delivery *
☐	in Calendar description (max. 40 words or 200 characters)	☐	retire/expire course
☐	other (please specify):	☐	

Change From:	**To:**
Mode of delivery: LECT	Mode of delivery: LECT, BLEN, ONLN, ONCA

Rationale:

BC3010 is a unique, highly specialized course within the Faculty. During the pandemic the course was offered successfully in an online format. The course structure requires substantial independent work and is well suited to any delivery format. It serves peer leaders from across the university (primarily Science, Lassonde and Health), which can pose a challenge for fitting into student schedules. In addition, expertise in leadership theory and practice is not common among faculty members, limiting the number of qualified instructors for the course. Having different options in terms of delivery modes for the course will provide greater flexibility to our programming and will benefit both students and instructors.

Offering greater course flexibility aligns with York University's current Academic Plan. For example, one of York's six priority areas of action addresses 21st century learning where one objective is to, "offer a wider range of credentials and flexible delivery options, from in-person to virtual, to expand access to learning for diverse individuals at multiple stages of their lives and careers" (https://yfile.news.yorku.ca/2020/06/28/york-university-launches-new-academic-plan-for-2020-to-2025/).

The Faculty of Science's Strategic Planning Mandate (2021-25) also encourages units to "optimize online and blended in-person/online courses and programs to diversify learning" (https://www.yorku.ca/science/about/strategic-plan/).

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

	A	B	F	G	H	I	K
1	Subj	Crs Nu	Cross-Listed to/integrated to:	CURRENT -Short Calendar Description	Calendar description (pre-req update only)	updated calendar description (with no changes to pre-req)	Long Course Description
116	GEOG	1401	SC/GEOG1401 3.00	What is climate change and how will it impact the environment? Learn how Earth's climate and weather systems work and explore the drivers of current and past climatic change. Discover how climate and climate change influence global biodiversity patterns. Gain practical experience applying the scientific method to address pressing environmental challenges related to climate change. Course Credit Exclusions: EU/GEOG 1400 6.00; AP/GEOG 1400 6.00; SC/GEOG 1400 6.00	No Change	No Change	The Earth is constantly changing. Many of these changes are natural. More recently, humankind has imposed several new challenges for the planet and its inhabitants, including but not limited to habitat loss, pollution, loss of biodiversity, and climate change. Physical geography examines the natural processes occurring at the Earth's surface that provide the physical setting for human activities. The total Earth system is divided into four realms, including land (lithosphere), water (hydrosphere), air (atmosphere), and living things (biosphere). Some systems occur at very small scales like that of an individual plant while others occur at very large scales encompassing the entire planet. Most systems do not operate independently but rather interact with
117	GEOG	1402	SC/GEOG1402 3.00	The Earth is constantly changing. Explore our global landscapes and the dynamic processes that have shaped the surface of the Earth throughout its history. Learn how interconnections among land, water, air, and living things drive variation in landforms, ecosystems, and biodiversity around the globe and through geologic time. Course Credit Exclusions: EU/GEOG 1400 6.00; AP/GEOG 1400 6.00; SC/GEOG 1400 6.00	No Change	No Change	The Earth is constantly changing. Many of these are natural. More recently, humankind has imposed several new challenges for the planet and its inhabitants. Physical geography examines the processes and patterns in the natural environment that help us to understand human-environment interactions. The total Earth system is divided into realms. The systems that operate within the realms of the lithosphere, hydrosphere, and biosphere are the focus of the course. Some systems occur at very small scales like that of an individual plant while others occur at very large scales encompassing the entire planet. Most systems do not
128	GEOG	2340	SC/GEOG 2340 3.00 NOTIFY SC for approval	This course covers fundamental concepts and approaches of geographical information systems, remote sensing and global positioning systems. Students also acquire knowledge and skills in descriptive statistics, map design and interpretation, and basic computer cartography. Prerequisite: AP/GEOG 1000 6.00 or AP/GEOG 1400 6.00 or AP/GEOG 1410 6.00 or written permission of the Instructor. Course credit exclusions: AP/GEOG 2350 3.00 (prior to Fall 2013), SC/GEOG 2350 3.00 (prior to Fall 2013), LE/EATS 2610 2.00 (prior to Summer 2013), LE/ENG 2110 2.00 (prior to Summer 2013).PRIOR TO SUMMER 2013: Prerequisite: AP/GEOG 1000 6.00 or AP/GEOG 1400 6.00 or AP/GEOG 1410 6.00 or written permission of the Instructor. Course credit exclusions: AP/GEOG 2350 3.00 (prior to Fall 2013), SC/GEOG 2350 3.00 (prior to Fall 2013), SC/EATS 2610 2.00, SC/ENG 2110 2.00.	This course covers fundamental concepts and approaches of geographical information systems, remote sensing and global positioning systems. Students also acquire knowledge and skills in descriptive statistics, map design and interpretation, and basic computer cartography. Prerequisite: EU/GEOG 1000 6.00 or EU/GEOG 1401 3.0, EU/GEOG 1402 3.0 or ~~AP/GEOG 1410 6.00~~ or written permission of the Instructor. ~~Course credit exclusions: AP/GEOG 2350 3.00 (prior to Fall 2013), SC/GEOG 2350 3.00 (prior to Fall 2013), LE/EATS 2610 2.00 (prior to Summer 2013), LE/ENG 2110 2.00 (prior to Summer 2013).PRIOR TO SUMMER 2013: Prerequisite: AP/GEOG 1000 6.00 or AP/GEOG 1400 6.00 or AP/GEOG 1410 6.00 or written permission of the Instructor. Course credit exclusions: AP/GEOG 2350 3.00 (prior to Fall 2013), SC/GEOG 2350 3.00 (prior to Fall 2013), SC/EATS 2610 2.00, SC/ENG 2110 2.00.~~	"This course covers fundamental concepts and approaches of geographical information systems, remote sensing and global positioning systems. Students also acquire knowledge and skills in descriptive statistics, map design and interpretation, and basic computer cartography. Two hour lecture, two hour lab.Prerequisite: EU/GEOG 1000 6.00 or EU/GEOG 1401 3.0, EU/GEOG 1402 3.0
130	GEOG	2402	SC/GEOG2420 3.00	Examines the physical processes and the environmental factors that govern the movement of water and energy in lakes, rivers, oceans and the soil-plant-atmosphere continuum. Prerequisite: EU/SC/GEOG 2401 3.00 Course Credit Exclusions: EU/GEOG 2400 6.00; AP/GEOG 2400 6.00; SC/GEOG 2400 6.00	No Change	No Change	This course examines the movement and storage of water in various phases near the Earth's surface and the energy required for fueling the hydrologic cycle. The focus of the course is on the interdependency of water and energy in the Hydrosphere. This includes the physical processes and the environmental factors that govern the movement of water and energy in lakes, rivers, oceans and the soil-plant-atmosphere continuum. The course traces the flow of energy and water initially in simple vegetation-free environments, and ultimately in more complex forest systems, where the role of plants in the hydrologic cycle is
131	GEOG	2420	SC/GEOG2420 3.00	The course offers an introduction to the skills necessary to pursue and understand statistical data analysis. Topics include: graphing, frequency distributions, measures of central tendency, an introduction to probability, statistical inference, hypothesis testing, and regression. Prerequisite: Second, Third or Fourth year standing or by permission of the instructor. 24 credits successfully completed. Course Credit Exclusions : AP/ECON 2500 3.00, AP/POLS 3300 6.00, AP/SOCI 3030 6.00, AP/SOCI 3030 3.0, HH/KINE 2050 3.00, HH/KINE 3150 3.00, HH/PSYC 2020 6.00, HH/PSYC 2021 3.00, SC/BIOL 2060 3.00, SC/MATH 2560 3.00, SC/MATH 2565 3.00, SC/MATH 2570 3.00,	The course offers an introduction to the skills necessary to pursue and understand statistical data analysis. Topics include: graphing, frequency distributions, measures of central tendency, an introduction to probability, statistical inference, hypothesis testing, and regression. Prerequisite: Second, Third or Fourth year standing or by permission of the instructor. 24 credits successfully completed. Course Credit Exclusions : AP/ECON 2500 3.00, AP/POLS 3300 6.00, AP/SOCI 3030 6.00, AP/SOCI 3030 3.0, HH/KINE 2050 3.00, HH/KINE 3150 3.00, HH/PSYC 2020 6.00, HH/PSYC 2021 3.00, SC/BIOL 2060 3.00, ~~SC/MATH 2560 3.00~~, SC/MATH 2565 3.00, ~~SC/MATH 2570 3.00~~,		
132	GEOG	2500	SC/GEOG2500 3.00	An introduction to the structure and functioning of vegetation and soil systems, emphasizing local patterns and processes, methods of description and sampling, dynamic processes, response to environmental change and human disturbance. Field work is emphasized in laboratories. One-day field trip. Prerequisite: AP/GEOG 1400 6.00 or SC/GEOG 1400 6.00 or ~~ES/ENVS 2500 6.00.~~	An introduction to the structure and functioning of vegetation and soil systems, emphasizing local patterns and processes, methods of description and sampling, dynamic processes, response to environmental change and human disturbance. Field work is emphasized in laboratories. One-day field trip. Prerequisite: EU/GEOG 1401 3.0, EU/GEOG 1402 3.0 or ES/ENVS 2500 6.00.		
133	GEOG	2600	SC/GEOG2600 3.00	This course concentrates on basic principles and fundamental concepts in geomorphology, including energy flows in geomorphic systems, hill slope forms and materials, weathering and landforms, and drainage basin geomorphology and hydrology (with a particular emphasis on Canadian examples).Prerequisite: AP/GEOG 1400 6.00 or SC/GEOG 1400 6.00 or LE/EATS 1010 3.00.PRIOR TO SUMMER 2013: Prerequisite: AP/GEOG 1400 6.00 or SC/GEOG 1400 6.00 or SC/EATS 1010 3.00.	This course concentrates on basic principles and fundamental concepts in geomorphology, including energy flows in geomorphic systems, hill slope forms and materials, weathering and landforms, and drainage basin geomorphology and hydrology (with a particular emphasis on Canadian examples).Prerequisite: EU/GEOG 1401 3.0, EU/GEOG 1402 3.0 or LE/EATS 1010 3.00.~~PRIOR TO SUMMER 2013: Prerequisite: AP/GEOG 1400 6.00 or SC/GEOG 1400 6.00 or SC/EATS 1010 3.00.~~		"This course concentrates on basic principles and fundamental concepts in geomorphology, including energy flows in geomorphic systems, hill slope forms and materials, weathering and landforms, and drainage basin geomorphology and hydrology (with a particular emphasis on Canadian examples).Prerequisite: AP/SC/GEOG 1400 6.00 or LE/EATS 1010 3.00. Course credit exclusions: None.PRIOR TO SUMMER 2013: Prerequisite: AP/SC/GEOG 1400 6.00 or SC/EATS 1010 3.00. Course credit exclusions: None.PRIOR TO FALL 2009: Prerequisite: AK/GEOG 2510 6.00 or AS/SC/GEOG 1400 6.00 or SC/EATS 1010 3.00. Course credit exclusions: AS/GEOG 2600 3.00, AS/SC/GEOG 2700 3.00 (prior to Fall/Winter 2004-2005).
134	GEOG	2610	SC/GEOG2610 3.00	This course concentrates on geomorphic processes and landforms (with a particular emphasis on Canadian examples). Five main areas are explored: fluvial forms and processes; the glaciation of Canada and glacial mechanics; periglaciation; aeolian processes; and coastal processes and landforms. Prerequisite: AP/SC/GEOG 2600 3.00. Course credit exclusions: None. PRIOR TO FALL 2009: Prerequisite: AS/SC/GEOG 2600 3.00. Course credit exclusions: AS/GEOG 2610 3.00, AS/SC/GEOG 3600 3.00 (prior to	This course concentrates on geomorphic processes and landforms (with a particular emphasis on Canadian examples). Five main areas are explored: fluvial forms and processes; the glaciation of Canada and glacial mechanics; periglaciation; aeolian processes; and coastal processes and landforms. Prerequisite: ~~AP/SC/GEOG 2600 3.00~~. Course credit exclusions: None. ~~PRIOR TO FALL 2009: Prerequisite: AS/SC/GEOG 2600 3.00. Course credit exclusions: AS/GEOG 2610 3.00, AS/SC/GEOG 3600 3.00 (prior to~~		
142	GEOG	3100	SC/GEOG3100 3.00	Climate change and pollution have their roots in human disruptions of natural biogeochemical cycling. Biogeochemical cycles describe how matter flows through ecosystems under the influence of biological and physical processes. Explore fundamental concepts in biogeochemistry and trace the cycling of carbon, nitrogen, phosphorus, sulfur, and mercury at global and local scales through lectures, case studies, and problem-solving exercises. Prerequisites: EU/SC/GEOG 1401 3.0 and EU/SC/GEOG 1402 3.0 (or	No Change	No Change	Climate change and pollution have their roots in human disruptions of natural biogeochemical cycling. Biogeochemical cycles describe how matter flows through ecosystems under the influence of biological and physical processes. Explore fundamental concepts in biogeochemistry and trace the cycling of carbon, nitrogen, phosphorus, sulfur, and mercury at global and local scales through lectures, case studies, and problem-solving exercises. Learning Outcomes:(1)Explain the origin and evolution of biogeochemical systems(2)Develop conceptual models to represent the biogeochemical cycling of carbon, nitrogen, phosphorus, sulfur, and mercury at global and local scales(3)Apply biogeochemical knowledge and analytical tools to environmental problem
146	GEOG	3200	SC/GEOG3200 3.00	An examination of the structure and function of vegetation and soil systems. The course focuses on such topics as the adjustment of ecosystems to human modification and the role of biogeography in conservation and resource management. Prerequisites: 54 credits successfully completed, including one of AP/GEOG 1400 6.00 or SC/GEOG 1400 6.00 or ES/ENVS 2420 3.00 or SC/BIOL 2050 4.00.	An examination of the structure and function of vegetation and soil systems. The course focuses on such topics as the adjustment of ecosystems to human modification and the role of biogeography in conservation and resource management. Prerequisites: 54 credits successfully completed, including one of EU/GEOG 1401 3.0, EU/GEOG 1402 3.00 or SC/GEOG 1401 3.0, SC/GEOG 1402 3.0 or ES/ENVS 2420 3.00 or SC/BIOL 2050 4.00.		
152	GEOG	3340	SC/GEOG3340 3.00	An introduction to the application of GIS to geographical/environmental problems. A broad conceptual overview of GIS approaches and their strengths and limitations. Students gain hands-on experience in the use of raster-based GIS technology with particular reference to resource management and planning topics. Prerequisite: AP/GEOG 2420 3.00 or SC/GEOG 2420 3.00. Course credit exclusions: AP/GEOG 3180 3.00 (prior to Fall 2013), SC/GEOG 3180 3.00 (prior to Fall 2013), ES/ENVS 3520 3.00.	An introduction to the application of GIS to geographical/environmental problems. A broad conceptual overview of GIS approaches and their strengths and limitations. Students gain hands-on experience in the use of raster-based GIS technology with particular reference to resource management and planning topics. Prerequisite: EU/GEOG 2420 3.00 or SC/GEOG 2420 3.00. EU/GEOG 2340 or SC/GEOG 2340. Course credit exclusions: AP/GEOG 3180 3.00 ~~(prior to Fall 2013), SC/GEOG 3180 3.00 (prior to Fall 2013), ES/ENVS 3520 3.00.~~		"An introduction to the application of GIS to geographical/environmental problems. A broad conceptual overview of GIS approaches and their strengths and limitations. Students gain hands-on experience in the use of raster-based GIS technology with particular reference to resource management and planning topics. Two hour lecture and two hour lab. Prerequisite: AP/SC/GEOG 2420 3.00. Course credit exclusions: AP/SC/GEOG 3180 3.00 (prior to Fall 2013), ES/ENVS 3520 3.00. PRIOR TO FALL 2009: Prerequisite: AS/SC/GEOG 2420 3.00. Course credit exclusions: ES/ENVS 3520 3.00, AS/GEOG 3180 3.00.

	A	B	F	G	H	I	K
1	Subj	Crs Nu	Cross-Listed to/integrated to:	CURRENT -Short Calendar Description	Calendar description (pre-req update only)	updated calendar description (with no changes to pre-req)	Long Course Description
153	GEOG	3360	SC/GEOG3360 3.00	This course is concerned with the systematic study of climate, vegetation, parent material, topography and time on the development, classification and chemistry of soils. A field trip and laboratory work will form part of this course.	No Change	No Change	AP/GEOG 3360 3.00 is based on AK/GEOG 3360 3.00.
157	GEOG	3440	SC/GEOG3440 3.00	Introduction to the methods in which remote sensing data are collected, processed and analyzed. An emphasis is placed on environmental applications. The synergy between the technologies of remote sensing and geographic information systems (GIS) is also stressed.Prerequisites: AP/GEOG 2420 3.00 or SC/GEOG 2420 3.00 or ES/ENVS 2010 6.00 and one 2000-level environmental studies theme foundation course; or written permission of the Instructor. Course credit exclusions: ES/ENVS 3521 3.00 (prior to Fall 2013). Previously offered as: AP/GEOG 3440 3.00, SC/GEOG 3440 3.00.	Introduction to the methods in which remote sensing data are collected, processed and analyzed. An emphasis is placed on environmental applications. The synergy between the technologies of remote sensing and geographic information systems (GIS) is also stressed.Prerequisites: EU/GEOG 2420 3.00 or SC/GEOG 2420 3.00 and one 2000-level environmental studies theme foundation course; or written permission of the Instructor. Course credit exclusions: ~~ES/ENVS 3521 3.00 (prior to Fall 2013).~~ Previously offered as: AP/GEOG 3440 3.00, SC/GEOG 3440 3.00.		"This course represents an introduction to the methods in which remote sensing data are collected, processed and analyzed. An emphasis is placed on environmental applications. The synergy between the technologies of remote sensing and geographic information systems (GIS) is also stressed. Two lecture hours, two laboratory hours. One term. Prerequisites: AP/SC/GEOG 2420 3.00 or ES/ENVS 2010 6.00 and one 2000-level environmental studies theme foundation course; or written permission of the course director. Course credit exclusions: AP/SC GEOG 3440 3.00 (prior to Fall 2013), ES/ENVS 3521 3.00 (prior to Fall 2013). PRIOR TO FALL 2009: Prerequisites: AS/SC/GEOG 2420 3.00 or ES/ENVS 2010 6.00 and one 2000-level environmental studies theme foundation course; or written permission of the course director. Course credit exclusion: AS/GEOG 3440 3.00.
158	GEOG	3500	SC/BIOL3500 3.00, SC/GEOG 3500 3.00	An analysis of the geography of plants and animals emphasizing processes that operate at the population level, the origin and diversity of plants and animals, geographic patterns of diversity, and dynamics of species populations from local to continental scales. Prerequisite: AP/GEOG 2500 3.00 or SC/GEOG 2500 3.00 or SC/BIOL 2050 4.00.	No Change	No Change	
159	GEOG	3510	SC/GEOG 3510 3.00	An examination of methods of laboratory analysis of soils and sediments including soil/sediment sampling, particle size, water and organic component analyses, microscopic analysis and data interpretation. Special emphasis is placed on methods of analysis in soil/sediment research.	No Change	No Change	AP/GEOG 3510 3.00 is based on AK/GEOG 3370 3.00.
161	GEOG	3540	SC/GEOG 3540 3.00	This course begins with lectures on field research methodology. The second phase concentrates on defining a field problem, leading to data collection in the field. The final part of the course deals with data analysis, and reviews methodological implications. Includes lectures, seminars and workshops, and a three to four day field trip.Prerequisites: Students must be registered as Honours majors in Geography or Environmental Science and must have successfully completed AP/GEOG 2420 3.00 and one of AP/GEOG 2400 6.00, AP/GEOG 2500 3.00 or AP/GEOG 2600 3.00; or permission of the Instructor. Course credit exclusions: SC/MATH 3330 3.00, AP/GEOG 4540 3.00 (prior to Fall 2012), SC/GEOG 4540 3.00 (prior to Fall 2012).	This course begins with lectures on field research methodology. The second phase concentrates on defining a field problem, leading to data collection in the field. The final part of the course deals with data analysis, and reviews methodological implications. Includes lectures, seminars and workshops, and a three to four day field trip.Prerequisites: Students must be registered as Honours majors in Geography or Environmental Science and must have successfully completed EU/GEOG 2420 3.00 and ~~one of AP/GEOG 2400 6.00~~, EU/GEOG 2500 3.00 or EU/GEOG 2600 3.00; or permission of the Instructor. Course credit exclusions: SC/MATH 3330 3.00, ~~AP/GEOG 4540 3.00 (prior to Fall 2012)~~, SC/GEOG 4540 3.00 (prior to Fall 2012).		"This course begins with lectures on field research methodology. The second phase concentrates on defining a field problem, leading to data collection in the field. The final part of the course deals with data analysis, and reviews methodological implications. Two two-hour periods per week (including lectures, seminars and workshops), a three to four day field trip. One term. Prerequisites: Students must be registered as Honours majors in Geography or Environmental Science and must have successfully completed AP/GEOG 2420 3.00 and one of AP/GEOG 2400 6.00, AP/GEOG 2500 3.00 or AP/GEOG 2600 3.00; or permission of the instructor. Course credit exclusions: SC/MATH 3330 3.00, AP/SC/GEOG 3420 3.00, AP/SC/GEOG 4540 3.00 (prior to Fall 2012). PRIOR TO FALL 2009: Prerequisites: Students must be registered as Honours majors in Geography or Environmental Science and must have successfully completed AS/GEOG 2420 3.00 and one of AS/GEOG 2400 6.00, AS/GEOG 2500 3.00 or AS/GEOG 2600 3.00; or permission of the instructor. Course credit exclusions: AK/MATH 3330 3.00, AS/GEOG 4540
167	GEOG	3700	SC/GEOG 3700 3.00	Geographical perspectives on the physical processes behind extreme natural events (volcanoes, tsunami, tornadoes, hurricanes) and their impact on people. Many case studies and the literature will be used to understand how physical geography impacts human activities and settlements. Prerequisite: AP/GEOG 2600 3.00 or SC/GEOG 2600 3.00.	Geographical perspectives on the physical processes behind extreme natural events (volcanoes, tsunami, tornadoes, hurricanes) and their impact on people. Many case studies and the literature will be used to understand how physical geography impacts human activities and settlements. Prerequisite: EU/GEOG 2600 3.00 or SC/GEOG 2600 3.00.		
172	GEOG	3900	SC/GEOG 3900 3.00	This course explores the natural and physical systems of the city, focusing on the climate, water, geomorphology, biogeography of the urban landscape, including its built environment. Course credit exclusions: None. PRIOR TO FALL 2000: Course credit exclusion: AS/GEOG 3900 3.00.	No Change	No Change	
173	GEOG	4000	SC/GEOG 4000 3.00	An independent piece of research done under the supervision of a faculty adviser. The thesis must be submitted before the end of classes in the winter term; an exact date is established each year. There is an oral examination on the Honours thesis. One lecture hour per week at the beginning of the course. Prerequisite: 84 credits passed.	No Change	No Change	F93 is effective term for course view above
165	GEOG	4180	SC/GEOG4180 3.00	This course introduces students to a comprehensive range of laboratory techniques for the analysis of plant, soil and water samples. Laboratory sessions and projects provide students with experience in analytical procedures and the operation of major items of laboratory equipment. Four scheduled lecture/laboratory hours, three additional laboratory hours. One term. Prerequisite: Six credits in physical geography at the 3000 or 4000 level or ES/ENVS 2410 3.00 or ES/ENVS 2420 3.00 or LE/EATS 1010 3.00 or SC/BIOL 2050 4.00. Course credit exclusions: None. PRIOR TO SUMMER 2013: Prerequisite: Six credits in physical geography at the 3000 or 4000 level or ES/ENVS 2410 3.00 or ES/ENVS 2420 3.00 or SC/EATS 1010 3.00 or SC/BIOL 2050 4.00. Course credit exclusions: None. PRIOR TO FALL 2009: Prerequisite: Six credits in physical geography at the 3000 or 4000 level or ES/ENVS 2410 3.00 or ES/ENVS 2420 3.00 or SC/EATS 1010 3.00 or SC/BIOL 2050 4.00. Course credit exclusion: AS/GEOG 4180 3.00.	This course introduces students to a comprehensive range of laboratory techniques for the analysis of plant, soil and water samples. Laboratory sessions and projects provide students with experience in analytical procedures and the operation of major items of laboratory equipment. Four scheduled lecture/laboratory hours, three additional laboratory hours. One term. Prerequisite: Six credits in physical geography at the 3000 or 4000 level or ES/ENVS 2410 3.00 or ES/ENVS 2420 3.00 or LE/EATS 1010 3.00 or SC/BIOL 2050 4.00. ~~Course credit exclusions: None. PRIOR TO SUMMER 2013: Prerequisite: Six credits in physical geography at the 3000 or 4000 level or ES/ENVS 2410 3.00 or ES/ENVS 2420 3.00 or SC/EATS 1010 3.00 or SC/BIOL 2050 4.00. Course credit exclusions: None. PRIOR TO FALL 2009: Prerequisite: Six credits in physical geography at the 3000 or 4000 level or ES/ENVS 2410 3.00 or ES/ENVS 2420 3.00 or SC/EATS 1010 3.00 or SC/BIOL 2050 4.00. Course credit exclusion: AS/GEOG 4180 3.00.~~		"This course introduces students to a comprehensive range of laboratory techniques for the analysis of plant, soil and water samples. Laboratory sessions and projects provide students with experience in analytical procedures and the operation of major items of laboratory equipment. Four scheduled lecture/laboratory hours, three additional laboratory hours. One term. Prerequisite: Six credits in physical geography at the 3000 or 4000 level or ES/ENVS 2410 3.00 or ES/ENVS 2420 3.00 or LE/EATS 1010 3.00 or SC/BIOL 2050 4.00. Course credit exclusions: None. PRIOR TO SUMMER 2013: Prerequisite: Six credits in physical geography at the 3000 or 4000 level or ES/ENVS 2410 3.00 or ES/ENVS 2420 3.00 or SC/EATS 1010 3.00 or SC/BIOL 2050 4.00. Course credit exclusions: None. PRIOR TO FALL 2009: Prerequisite: Six credits in physical geography at the 3000 or 4000 level or ES/ENVS 2410 3.00 or ES/ENVS 2420 3.00 or SC/EATS 1010 3.00 or SC/BIOL 2050 4.00. Course credit exclusion: AS/GEOG 4180 3.00.
167	GEOG	4200	SC/GEOG 4200 3.00	The course focuses on selected aspects of river water quality, including hillslope hydrology and the transport of pollutants, the impacts of human activities on water chemistry, nutrient transformations within stream ecosystems, and the effects of water quality on stream biological communities.Prerequisite: AP/GEOG 1400 6.00 or SC/GEOG 1400 6.00, ES/ENVS 2410 3.00, or SC/BIOL 2050 4.00.	The course focuses on selected aspects of river water quality, including hillslope hydrology and the transport of pollutants, the impacts of human activities on water chemistry, nutrient transformations within stream ecosystems, and the effects of water quality on stream biological communities.Prerequisite: EU/GEOG 1401 3.0, EU/GEOG 1402 3.0 or EU/SC/GEOG 1401 3.0, EU/SC/GEOG 1402 3.0, ES/ENVS 2410 3.00, or SC/BIOL 2050 4.00.		
169	GEOG	4205	SC/GEOG 4205 3.00	A study of the processes of energy and moisture exchanges in polar regions with emphasis on the Canadian north. Topics include atmospheric and oceanic transport of energy, surface microclimate and the sensitivity of high latitude environments to climate change. Normally offered in alternate years.Prerequisites: 54 credits successfully completed, including AP/GEOG 2400 6.00 or SC/GEOG 2400 6.00 or written permission of the Instructor.	A study of the processes of energy and moisture exchanges in polar regions with emphasis on the Canadian north. Topics include atmospheric and oceanic transport of energy, surface microclimate and the sensitivity of high latitude environments to climate change. Normally offered in alternate years.Prerequisites: 54 credits successfully completed, including AP/GEOG 2400 6.00 or SC/GEOG 2400 6.00 or written permission of the Instructor.		FW2002: Continues with the removal of an obsolete degree credit exclusion.
169	GEOG	4210	SC/GEOG 4210 3.00	A study of the relationship between the atmosphere and the hydrosphere with the emphasis on the process of evaporation. The course includes an in-depth review of evaporation models and the instrumentation necessary for data acquisition. Normally offered in alternate years.Prerequisite: AP/GEOG 2400 6.00 or SC/GEOG 2400 6.00.	A study of the relationship between the atmosphere and the hydrosphere with the emphasis on the process of evaporation. The course includes an in-depth review of evaporation models and the instrumentation necessary for data acquisition. Normally offered in alternate years.Prerequisite: AP/GEOG 2400 6.00 or SC/GEOG 2400 6.00.		F99 is effective term for contact hours above

	A	B	F	G	H	I	K
1	Subj	Crs Nu	Cross-Listed to/integrated to:	CURRENT -Short Calendar Description	Calendar description (pre-reg update only)	updated calendar description (with no changes to pre-reg)	Long Course Description
190	GEOG	4215	SC/GEOG 4215 3.00	The field of Ecological Climatology provides an interdisciplinary framework for understanding how terrestrial ecosystems function in relation to climate systems. It examines the physical, chemical and biological processes by which landscapes affect and are affected by climate. The central theme is that ecosystems, through their cycling of energy, water, chemical elements and trace gases are important determinants of climate. The coupling between climate and vegetation is seen at spatial scales from the leaf to biomes and at timescales from seconds to millenia. Both natural vegetation dynamics and human induced land-use changes are mechanisms of climate change. The course combines a theoretical understanding of ecological climatology with applied experimentation to reinforce the principals involved. Prerequisite: AP/SC GEOG 2400 6.00; and either AP/GEOG 2500 3.00 or SC/GEOG 2500 3.00 or SC/BIOL 2050 4.00; and either AP/GEOG 2420 3.00 or SC GEOG 2420 3.00 or SC/BIOL 2060 3.00. Graduate student prerequisites: With permission of the Instructor.	The field of Ecological Climatology provides an interdisciplinary framework for understanding how terrestrial ecosystems function in relation to climate systems. It examines the physical, chemical and biological processes by which landscapes affect and are affected by climate. The central theme is that ecosystems, through their cycling of energy, water, chemical elements and trace gases are important determinants of climate. The coupling between climate and vegetation is seen at spatial scales from the leaf to biomes and at timescales from seconds to millenia. Both natural vegetation dynamics and human induced land-use changes are mechanisms of climate change. The course combines a theoretical understanding of ecological climatology with applied experimentation to reinforce the principals involved. Prerequisite: EU/SC GEOG 2401 3.00 and EU/SC GEOG 2402; and either EU/GEOG 2500 3.00 or SC/GEOG 2500 3.00 or SC/BIOL 2050 4.00; and either EU/GEOG 2420 3.00 or SC GEOG 2420 3.00 or SC/BIOL 2060 3.00. Graduate student prerequisites: With permission of the Instructor.		"The field of Ecological Climatology provides an interdisciplinary framework for understanding how terrestrial ecosystems function in relation to climate systems. It examines the physical, chemical and biological processes by which landscapes affect and are affected by climate. The central theme is that ecosystems, through their cycling of energy, water, chemical elements and trace gases are important determinants of climate.The coupling between climate and vegetation is seen at spatial scales from the leaf to biomes and at timescales from seconds to millenia. Both natural vegetation dynamics and human induced land-use changes are mechanisms of climate change. The course combines a theoretical understanding of ecological climatology with applied experimentation to reinforce the principals involved.Prerequisite: AP/SC GEOG 2400 6.00; and either AP/SC GEOG 2500 3.00 or SC/BIOL 2050 4.00; and either AP/SC GEOG 2420 3.00 lor SC/BIOL 2060 3.00. Graduate student prerequisites: With permission of the instructor. Course credit exclusions: None.
195	GEOG	4290	SC/GEOG 4290 6.00	This course may be used for individualized study, in which case the student requires permission from a faculty member who agrees to supervise the program of directed reading and from the Chair of the department. Note: See the Faculty of Liberal Arts and Professional Studies section of the Undergraduate Programs Calendar for Faculty of Liberal Arts and Professional Studies regulations on Independent Reading Courses.	This course may be used for individualized study, in which case the student requires permission from a faculty member who agrees to supervise the program of directed reading and from the Program Coordintor or Undergraduate Program Director. ~~Chair of the department. Note: See the Faculty of Liberal Arts and Professional Studies section of the Undergraduate Programs Calendar for Faculty of Liberal Arts and Professional Studies regulations on Independent Reading Courses.~~		
196	GEOG	4290	SC/GEOG 4290 3.00	This course may be used for individualized study, in which case the student requires permission from a faculty member who agrees to supervise the program of directed reading and from the Chair of the department. Note: See the Faculty of Liberal Arts and Professional Studies section of the Undergraduate Programs Calendar for Faculty of Liberal Arts and Professional Studies regulations on Independent Reading Courses.	This course may be used for individualized study, in which case the student requires permission from a faculty member who agrees to supervise the program of directed reading and from the Chair of the department. ~~Note: See the Faculty of Liberal Arts and Professional Studies section of the Undergraduate Programs Calendar for Faculty of Liberal Arts and Professional Studies regulations on Independent Reading Courses.~~		
197	GEOG	4310	SC/GEOG 4310 3.00	Examines the formation, distribution, structure and degradation of snow, as well as lake, river and sea ice. Normally offered in alternate years. Prerequisite: AP//GEOG 2400 6.00 or SC/GEOG 2400 6.00.	Examines the formation, distribution, structure and degradation of snow, as well as lake, river and sea ice. Normally offered in alternate years. Prerequisite: EU/GEOG 2401 3.00 and EU/GEOG 2402 3.0 or SC/GEOG 2401 3.00 and SC/GEOG 2402 3.00.		
198	GEOG	4340	SC/GEOG 4340 3.00	Advanced course in geographic information systems (GIS), oriented around raster structures. Computer graphics for mapping introduced and work undertaken on finely divided surfaces. GIS considers both practical and theoretical questions of interpretation. Macintosh computers and raster-based software used for hands-on focus.Prerequisite: AP/GEOG 3340 3.00 or SC/GEOG 3340 3.00. PRIOR TO FALL 2013: Previously offered as: AP/GEOG 4340 3.00, SC/GEOG 4340 3.00.	Advanced course in geographic information systems (GIS), oriented around raster structures. Computer graphics for mapping introduced and work undertaken on finely divided surfaces. GIS considers both practical and theoretical questions of interpretation. Macintosh computers and raster-based software used for hands-on focus.Prerequisite: EU/GEOG 3340 3.00 or SC/GEOG 3340 3.00. ~~PRIOR TO FALL 2013: Previously offered as: AP/GEOG 4340 3.00, SC/GEOG 4340 3.00.~~		"Advanced course in geographic information systems (GIS), oriented around raster structures. Computer graphics for mapping introduced and work undertaken on finely divided surfaces. GIS considers both practical and theoretical questions of interpretation. Macintosh computers and raster-based software used for hands-on focus. Two lecture hours, two laboratory hours. One term. Prerequisite: AP/SC/GEOG 3340 3.00. Course credit exclusion: AP/SC/GEOG 4340 3.00 (prior to Fall 2013). PRIOR TO FALL 2009: Prerequisite: AS/SC/GEOG 3180 3.00. Course credit exclusion: AS/GEOG 4340 3.00.
199	GEOG	4400	SC/GEOG 4400 3.00	An intermediate course in the physical principles of hydrological and water resource systems. Topics to be discussed include groundwater storage and flow, deterministic hydrological models and physical hydrological aspects of current water resource problems. Normally offered in alternate years. Two lecture hours, two laboratory hours. One term. Prerequisite: AP/SC/GEOG 2400 6.00. Course credit exclusions: None. PRIOR TO FALL 2009: Prerequisite: AS/SC/GEOG 2400 6.00. Course credit exclusion: AS/GEOG 4400 3.00.	An intermediate course in the physical principles of hydrological and water resource systems. Topics to be discussed include groundwater storage and flow, deterministic hydrological models and physical hydrological aspects of current water resource problems. Normally offered in alternate years. Two lecture hours, two laboratory hours. One term. Prerequisite: EU/GEOG 2401 3.00 and EU/GEOG 2402 3.0 or SC/GEOG 2401 3.00 and SC/GEOG 2402 3.00. ~~Course credit exclusions: None. PRIOR TO FALL 2009: Prerequisite: AS/SC/GEOG 2400 6.00. Course credit exclusion: AS/GEOG 4400 3.00.~~		F96 is effective term for course view above
201	GEOG	4440	SC/GEOG 4440 3.00	Sophisticated methods and techniques for collecting, processing and analyzing remote sensing data are examined. Special topics include image enhancement techniques (e.g. texture transforms), non-traditional image classification and data integration for incorporation of remote sensing data products into geographic information systems (GIS). Prerequisite: AP/GEOG 3440 3.00 or ES/ENVS 3521 3.00 or LE/EATS 4220 3.00 or written permission of the Instructor. Course credit exclusions: ES/ENVS 4521 3.00 (prior to Fall 2013). Previously offered as: AP/GEOG 4440 3.00, SC/GEOG 4440 3.00.	Sophisticated methods and techniques for collecting, processing and analyzing remote sensing data are examined. Special topics include image enhancement techniques (e.g. texture transforms), non-traditional image classification and data integration for incorporation of remote sensing data products into geographic information systems (GIS). Prerequisite: EU/GEOG 3440 3.00 ~~or ES/ENVS 3521 3.00~~ or LE/EATS 4220 3.00 or written permission of the Instructor. ~~Course credit exclusions: ES/ENVS 4521 3.00 (prior to Fall 2013).~~ Previously offered as: AP/GEOG 4440 3.00, SC/GEOG 4440 3.00.		"Sophisticated methods and techniques for collecting, processing and analyzing remote sensing data are examined. Special topics include image enhancement techniques (e.g. texture transforms), non-traditional image classification and data integration for incorporation of remote sensing data products into geographic information systems (GIS). One and one-half lecture hours, one and one-half laboratory hours. One term. Prerequisite: AP/GEOG 3440 3.00 or ES/ENVS 3521 3.00 or LE/EATS 4220 3.00 or written permission of the course director. Course credit exclusions: AP/SC/GEOG 4440 3.00 (prior to Fall 2013), ES/ENVS 4521 3.00 (prior to Fall 2013). PRIOR TO SUMMER 2013: Prerequisite: AP/GEOG 3440 3.00 or ES/ENVS 3521 3.00 or SC/EATS 4220 3.00 or written permission of the course director. Course credit exclusions: AP/SC/GEOG 4440 3.00 (prior to Fall 2013), ES/ENVS 4521 3.00 (prior to Fall 2013). PRIOR TO FALL 2009: Prerequisite: AS/SC/GEOG 3440 3.00 or ES/ENVS 3521 3.00 or SC/EATS 4220
205	GEOG	4541	SC/GEOG 4541 3.00	This course applies geographic principles and field techniques to problems in physical geography during a field trip of at least one weeks duration to a location normally outside of Ontario. Prerequisites: AP/GEOG 1400 6.00, AP/GEOG 2420 3.00, and students are encouraged to take AP/GEOG 3540 3.00 prior to taking this course. Priority will be given to Geography Honours and Environmental Science students having already completed 84 credits.	This course applies geographic principles and field techniques to problems in physical geography during a field trip of at least one weeks duration to a location normally outside of Ontario. Prerequisites: EU/GEOG 1401 3.00 and EU/GEOG 1402 3.00, EU/GEOG 2420 3.00 ~~, and students are encouraged to take EU/GEOG 3540 3.00 prior to taking this course.~~ Priority will be given to Global Geography Honours and Environmental Science students having already completed 84 credits.		
206		4600	SC/GEOG 4600 3.00	Provides fundamental knowledge of river mechanics and related environmental conditions. It provides an integration of physical, environmental and spatial aspects of river behaviour. The course involves the application of principles of hydrology, geomorphology, sedimentology and fluid mechanics.	No Change	No Change	

Changes to Existing Course

Faculty: Science

Department:	Natural Sciences	**Date of Submission:**	25-Sep-2023
Course Number:	NATS1512 3.0	**Effective Session:**	SU 2024
Course Title:	Environmental Pollution		

Type of Change:

☐	in pre-requisite(s)/co-requisite(s)	☐	in cross-listing
☐	in course number/level	☐	in degree credit exclusion(s)
☐	in credit value	☐	regularize course (from Special Topics)
☐	in title (max. 40 characters for short title)	X	in course format/mode of delivery *
☐	in Calendar description (max. 40 words or 200	☐	retire/expire course
☐	other (please specify): CCE clean-up	☐	

Change From:	**To:**
LECT	LECT, ONLN, ONCA

Rationale:	A new LA&PS BA program in Communication, Social Media & Public Relations will be launched at the Markham campus for Fall 2024 and the program has identified NATS environmental science courses of particular interest to their students. Given that space is limited for in-person NATS courses at the Markham campus and that there are other NATS courses identified as higher priority to be offered in-person at Markham, we would like to make one of our most popular environmental science courses - NATS1512 Environmental Polllution - accessible to Markham students by offering it in the online format during the summer term. While the course would most likely be offered in the ONCA format, we would like the flexibility of offering it entirely online (ONLN) in future terms should the professor decide to employ alternate forms of assessment which can be offered online while maintaining academic honesty.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Course Design:

Indicate how the course design supports students in achieving the learning objectives. For example, in the absence of scheduled contact hours what role does student-to-student and/or student-to-instructor communication play, and how is it encouraged?

Detail any aspects of the content, delivery, or learning goals that involve "face-to-face" communication, non-campus attendance or experiential education components.

Alternatively, explain how the course design encourages student engagement and supports student learning in the absence of substantial on-campus attendance.

During the pandemic, NATS1512 was successfully offered in a synchronized online format with online assessments. In the proposed ONCA/ONLN format, asynchronous lectures are posted on a weekly basis, amounting to the equivalent of 3 hours of lecture per week over 12 weeks. The ONLN/ONCA assessment scheme is similar to the scheme used in the LECT format of NATS1512 as well as the online version of NATS1512 offered during the pandemic, as follows:

- Weekly online multiple-choice quizzes pertaining to the lecture material: 6%
- Five exercises pertaining to online skills tutorials, each worth 1% with the lowest score dropped: 4%
- Four case studies, each worth 1% with the lowest score dropped: 3%
- Three assignments on air, soil and water pollution, each worth 10%: 30%
- Two tests, each worth 16%: 32%
- Final exam: 25%

In the proposed ONCA format, the tests and exam are held in person, in invigilated test sessions held at both the Markham and Keele campus.

In the REMT format offered during the pandemic, the tests were open-book assessments requiring lengthier responses and longer submission windows. The instructor is currently investigating alternate methods for maintaining academic honesty in online testing and may choose to adopt such methods so that an ONLN version can be offered in the future.

In the proposed ONCA/ONLN format, the course director is available for online office hours via zoom, hours per week.

Learning outcomes for the ONLN/ONCA are the same as for the LECT version of NATS1512.

Instruction:

1. Planned frequency of offering and number of sections anticipated (every year, alternate years, etc.).
2. Number of department members currently competent to teach the course.
3. Instructor(s) likely to teach the course in the coming year.
4. An indication of the number of contact hours (defined in terms of hours, weeks, etc.) involved, in order to indicate whether an effective length of term is being maintained **OR** in the absence of scheduled contact hours a detailed breakdown of the estimated time students are likely to spend engaged in learning activities required by the course.

1. NATS1512 will typically be offered in the ONCA format every other summer.
2. Stephanie Domenikos (current instructor), Ian Lumb
3. Stephanie Domenikos
4. In the proposed ONCA/ONLN format, students receive the equivalent of 3 lecture hours per week of asynchronous online lecture content over the course of 12 weeks, amounting to 36 contact/learning hours.

Changes to Existing Course

Faculty: Science

Department:	Natural Sciences	**Date of Submission:**	13-Sep-2023
Course Number:	NATS1765 6.0	**Effective Session:**	FW 2024-25
Course Title:	Science, Experts and Citizens		

Type of Change:

[ ]	in pre-requisite(s)/co-requisite(s)	[ ]	in cross-listing
[ ]	in course number/level	[ ]	in degree credit exclusion(s)
[ ]	in credit value	[ ]	regularize course (from Special Topics)
[ ]	in title (max. 40 characters for short title)	[X]	in course format/mode of delivery *
[ ]	in Calendar description (max. 40 words or 200	[ ]	retire/expire course
[ ]	other (please specify): CCE clean-up	[ ]	

Change From:	**To:**
LECT	LECT, ONLN, ONCA

Rationale:	A new LA&PS BA program in Communication, Social Media & Public Relations will be launched at the Markham campus for Fall 2024 and the program has identified NATS1765 as a course of particular interest to their students. Given that space is limited for in-person NATS courses at the Markham campus and that there are other NATS courses identified as higher priority to be offered in-person at Markham, we would like to make NATS1765 accessible to Markham students by offering it in the online format during the summer term. While the course would most likely be offered in the ONCA format, we would like the flexibility of offering it entirely online (ONLN) in future terms should the professor decide to employ alternate forms of assessment which can be offered online while maintaining academic honesty.

Note: For course proposals involving cross-listings, integrations and degree credit exclusions, approval from all of the relevant Faculties/department is required.

Note: Since one change (such as a change in year level or credit value) may result in several other changes (e.g., to the course description, evaluation, instruction, bibliography, etc.), please submit as many details as possible. If there are several changes, please feel free to use a New Course Proposal Form in order to ensure that all the required information is included.

* Note: If there is a technology component to the course, a statement is required from ATS indicating whether resources are adequate to support the course. Courses converted from face-to-face to an on-line delivery mode should follow the instructions provided on page 4 of the New Course Proposal Form to provide revised 'Course Design' and 'Method of Instruction" information.

Course Design:

Indicate how the course design supports students in achieving the learning objectives. For example, in the absence of scheduled contact hours what role does student-to-student and/or student-to-instructor communication play, and how is it encouraged?

Detail any aspects of the content, delivery, or learning goals that involve "face-to-face" communication, non-campus attendance or experiential education components.

Alternatively, explain how the course design encourages student engagement and supports student learning in the absence of substantial on-campus attendance.

During the pandemic, NATS1765 was successfully offered in a synchronized online format with online assessments. In the proposed ONCA/ONLN format, asynchronous lectures are posted on a weekly basis, amounting to the equivalent of 3 hours of lecture per week over 24 weeks (or, 6 hours of lecture per week during the summer double-speed term). The assessment scheme is similar to the scheme used in the LECT format of NATS1765 as well as the online version of NAT1765 offered during the pandemic, as follows:

- Academic integrity quiz: 2% (passing this quiz unlocks the other assignments)
- Weekly summaries/reflections of the lesson material, in the form of either short written assignments or guided asynchronous online discussions on eClass (to encourage engagement with peers): 20%
- Four tests, each worth 26% with the lowest score dropped: 78%

In the proposed ONCA format, the 4 tests are held in person, in invigilated test sessions held at both the Markham and Keele campus.

In the REMT format offered during the pandemic, the 4 tests were open-book assessments requiring lengthier responses and longer submission windows. The instructor is currently investigating alternate methods for maintaining academic honesty in online testing and may choose to adopt such methods so that an ONLN version can be offered in the future.

In the proposed ONCA/ONLN format, the course director is available for online office hours via zoom, hours per week.

Learning outcomes for the ONLN/ONCA are the same as for the LECT version of NATS1765.

Instruction:

1. Planned frequency of offering and number of sections anticipated (every year, alternate years, etc.).
2. Number of department members currently competent to teach the course.
3. Instructor(s) likely to teach the course in the coming year.
4. An indication of the number of contact hours (defined in terms of hours, weeks, etc.) involved, in order to indicate whether an effective length of term is being maintained **OR** in the absence of scheduled contact hours a detailed breakdown of the estimated time students are likely to spend engaged in learning activities required by the course.

1. NATS1765 will typically be offered in the ONCA format every other year, giving Markham students the opportunity to complete their 6 NATS credits in either their 1st or 2nd year.
2. James Elwick (current instructor), Conor Douglas
3. James Elwick
4. In the proposed ONCA/ONLN format, students receive the equivalent of 3 lecture hours per week of asynchronous online lecture content over the course of 24 weeks, amounting to 72 contact/learning hours. In the Summer double-speed format, this amounts to 6 contact/learning hours per week.