SFU OFFICE OF THE ASSOCIATE VICE-PRESIDENT, ACADEMIC

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MEMORANDUM

ATTENTION	Senate	**DATE**	March 4, 2016
FROM	Mark Lechner, Acting Chair	**PAGES**	1/1
	Senate Committee on		
	Undergraduate Studies		
RE:	Faculty of Science (SCUS 16-06a)		

For information:

Acting under delegated authority at its meeting of March 3, 2016 SCUS approved the following curriculum revisions effective Fall 2016.

1. Department of Physics (SCUS 16-06a)

   (i) New Course Proposal: PHYS 201-1, Physics Undergraduate Seminar
   (ii) Upper and Lower division requirement changes to the Applied Physics Honours program
   (iii) Lower division requirement changes to the Chemical Physics Honours and Mathematical Physics Honours programs
   (iv) Upper and Lower division requirement changes to the Physics Honours, Biological Physics Honours, Applied Physics, Biological Physics
   (v) Lower division requirement changes to the Physics program
   (vi) Upper and Lower division requirement changes to the Chemical Physics

COURSE SUBJECT | PHYS   **NUMBER** | 201

COURSE TITLE

LONG — for Calendar/schedule, no more than 100 characters including spaces and punctuation

Physics Undergraduate Seminar

AND

SHORT — for enrollment/transcript, no more than 30 characters including spaces and punctuation

Physics Undergrad Seminar

CAMPUS where course will be normally taught: ■ Burnaby ☐ Surrey ☐ Vancouver ☐ Great Northern Way ☐ Off campus

COURSE DESCRIPTION (FOR CALENDAR). 50 WORDS MAXIMUM. ATTACH A COURSE OUTLINE TO THIS PROPOSAL

A seminar to expose students majoring in any Physics program to opportunities available with a physics degree. Seminar will include invited speakers, group discussions, and student presentations on topics including modern physics research, industrial physics, career opportunities, and communication and other professional skills. May be repeated once for credit. Graded as pass/fail (P/F).

REPEAT FOR CREDIT ■ YES ☐ NO How many times? | 1   Within a term? ☐ YES ■ NO

LIBRARY RESOURCES

NOTE: Senate has approved (S.93-11) that no new course should be approved by Senate until funding has been committed for necessary library materials. Each new course proposal must be accompanied by a library report and, if appropriate, confirmation that funding arrangements have been addressed.

Library report status, see lib.sfu.ca/collections/course-assessments

RATIONALE FOR INTRODUCTION OF THIS COURSE

If more space is needed, please use the provided text box on page 4 of this document

The primary goal of this course is to enrich the student experience beyond their academic training by creating a community of Physics students, exposing them to opportunities available to students with a physics degree – including academic research opportunities, industrial physics, and nontraditional careers – and fostering skills necessary for success. Students are required to take the course once but may repeat for credit a second time, as topics and guest speakers will vary from year to year.

Piloted as a Special Temporary Topics course in FALL 2015/SPRING 2016. PHYS 201 will span the Fall/Spring semester with one hour of seminar each week.

SCHEDULING AND ENROLLMENT INFORMATION

Term and year course would first be offered (e.g. FALL 2014) | FALL 2016

Term(s) in which course will typically be offered ☐ Spring ☐ Summer ☐ Fall

■ Other *(describe)* | Course spans Fall/Spring semesters

Will this be a required or elective course in the curriculum? ■ Required ☐ Elective

What is the probable enrollment when offered? Estimate: | 40

UNITS

Indicate number of units: | 1

Indicate no. of contact hours for: [ ] Lecture | 1 Seminar [ ] Tutorial [ ] Lab [ ] Other – please explain

OTHER

FACULTY Which of your present CFL faculty have the expertise to offer this course?

All Physics faculty can teach this course.

WQB DESIGNATION (attach approval from Curriculum Office)

PREREQUISITE AND / OR COREQUISITE

Prerequisites: PHYS 121 or 126 or PHYS 141, (or PHYS 102 with a minimum grade of B).

EQUIVALENT COURSES

Does this course replicate the content of a previously-approved course to such an extent that students should not receive credit for both courses?

This course overlaps with no other courses.

COURSE – LEVEL EDUCATIONAL GOALS (OPTIONAL)

FEES

Are there any proposed student fees associated with this course other than tuition fees? [ ] YES [■] NO

RESOURCES

List any outstanding resource issues to be addressed prior to implementation: space, laboratory equipment, etc:

None

OTHER IMPLICATIONS

Final Exam required: ☐ YES ☐ NO

Criminal Record Check required: ☐ YES ☒ NO

OVERLAP CHECK

Checking for overlap is the responsiblity of the Associate Dean.

Each new course proposal must have confirmation of an overlap check completed prior to submission to the Faculty Curriculum Committee.

Name of Originator

Jeffrey McGuirk, Undergraduate Chair, Department of Physics

Rationale: Program changes:

Motions 5-9 primarily propose to reduce the number of units required for an Honours degree from 132 units. Lowering degree requirements will reduce completion times, ease crowded semesters, and encourage more students to pursue Honours degrees. Other program changes are made as noted.

1. **To make the following changes to the Applied Physics Honours (APPHHON) degree.**
   a) To reduce the total units from 132 to 121.
      Rationale: See above. No other program changes are required to accomplish this.
      b) To add PHYS 201-1 Physics Undergraduate Seminar to the Lower Division Requirements.
      Rationale: All students will benefit from the cohort building of our new seminar. See Motion 1.
   c) To delete the required 3 CMPT courses (102, 150, 250) and replace with "9 units chosen from MACM 101, CMPT 102, 120, 125, 127, 128, or any 200-level CMPT course"
      Rationale: Computing has discontinued computer architecture courses CMPT 150 & 250. In lieu of these courses, any 100 or 200-level rigorous programming courses may be taken.
   d) To place PHYS 455 and 465 & NUSC 341 and 346 into the list of applied breadth courses from which students must choose, and update the minimum units to 17.
      Rationale: Applied physics degrees take a number of forms, including applied optics, materials science, electronics engineering, radiochemistry, and more. This change harmonizes the applied electives for the Honours and regular programs. Additionally, moving PHYS 455 and 465 to the list of electives permits the flexibility of not offering these low-enrollment courses every year.

2. **To make the following changes to the Chemical Physics Honours (CHPHHON) degree.**
   a) To reduce the total units from 132 to 123.
      Rationale: See above. No other program changes are required to accomplish this.
   b) To add PHYS 201-1 Physics Undergraduate Seminar to the Lower Division Requirements.
      Rationale: All students will benefit from the cohort building of our new seminar. See Motion 1.

3. **To make the following changes to the Mathematical Physics Honours (MAPHHON) degree.**
   a) To reduce the total units from 132 to 120.
      Rationale: See above. No other program changes are required to accomplish this.
   b) To add PHYS 201-1 Physics Undergraduate Seminar to the Lower Division Requirements.
      Rationale: All students will benefit from the cohort building of our new seminar. See Motion 1.

4. **To make the following changes to the Physics Honours (PHYSHON) degree.**
   a) To reduce the total units from 132 to 120.
      Rationale: See above. No other program changes are required to accomplish this.
   b) To add PHYS 201-1 Physics Undergraduate Seminar to the Lower Division Requirements.
      Rationale: All students will benefit from the cohort building of our new seminar. See Motion 1.
   c) To remove the list of approved upper division PHYS electives and allow free choice of any upper division PHYS courses.
      Rationale: The selected list dates from when we offered two 6-unit 300-level lab courses, which we wished to exclude, and is an extremely arbitrary selection. We currently offer no upper division courses that would be unsuitable choices for PHYS Honours students.

5. **To make the following changes to the Biological Physics Honours (BIPHHON) degree.**
   a) To add PHYS 201-1 Physics Undergraduate Seminar to the Lower Division Requirements.
      Rationale: All students will benefit from the cohort building of our new seminar. See Motion 1.
   b) To reduce the total units from 132 to 126.

Rationale: See above. Currently this degree actually requires 134 units, higher even than joint major requirements. It is hoped that reducing these requirements will be more attractive and produce a more robust stream of students. The following changes are necessary to accomplish this reduction.

c) To move MBB 309W into Option A.
Rationale: Originally included to satisfy the upper division W requirement, certifying 433 as a W course alleviates this need (see MOTION 4). Moving into the MBB option equalizes the requirements of the MBB and Physics options. It is included in the list of recommended courses to cover the Physics option too.

d) To reduce the required PHYS/MBB upper division breadth choices from 4 to 2.
Rationale: There is substantial breadth already between upper division PHYS and MBB courses, and lower division units in PHYS, MATH, MBB, BISC, and CHEM. This reduction helps lower the total unit requirement to a more reasonable level.

e) To remove MBB 441 and MBB 442 from the list of suggested electives and add MBB 342.
Rationale: MBB 442 has been cancelled, and MBB 441 requires prerequisites not currently taken or suggested. Instead we add that prerequisite, MBB 342, to the suggested courses.

The next four motions concern the regular degree programs.

6. **To make the following changes to the Applied Physics (APPH) degree.**
   a) To add PHYS 201-1 Physics Undergraduate Seminar to the Lower Division Requirements.
   Rationale: All students will benefit from the cohort building of our new seminar. See Motion 1.
   b) To change the required 3 CMPT courses to "9 units chosen from MACM 101, CMPT 102, 120, 125, 127, 128, or any 200-level CMPT course"
   Rationale: Rationale: Computing has discontinued computer architecture courses CMPT 150 & 250. In lieu of these courses, any 100 or 200-level rigorous programming courses may be taken.
   c) To place PHYS 455, CHEM 340, and ENSC 426 & 495 into the list of applied breadth courses from which students must choose, and update the minimum units to 13.
   Rationale: Applied physics degrees take a number of forms, including applied optics, materials science, electronics engineering, radiochemistry, and more. This change harmonizes the applied electives for the Honours and regular programs. Additionally, moving PHYS 455 to the list of electives permits the flexibility of not offering this low-enrollment course every year.

7. **To make the following changes to the Biophysics Physics (BIPH) degree.**
   a) To add PHYS 201-1 Physics Undergraduate Seminar to the Lower Division Requirements.
   Rationale: All students will benefit from the cohort building of our new seminar. See Motion 1.
   b) To remove MBB 309W as a requirement and add it to the list of suggested courses.
   Rationale: Originally included to satisfy the upper division W requirement, certifying 433 as a W course alleviates this need.
   c) To remove MBB 441 and MBB 442 from the list of suggested electives and add MBB 342.
   Rationale: MBB 442 has been cancelled, and MBB 441 requires prerequisites not currently taken or suggested. Instead we add that prerequisite, MBB 342, to the suggested courses.

8. **To make the following change to the Physics (PHYS) degree: to add PHYS 201-1 Physics Undergraduate Seminar to the Lower Division Requirements.**
   Rationale: All students will benefit from the cohort building of our new seminar. See Motion 1

9. **To make the following changes to the Chemical Physics (CHPH) degree.**
   a) To add PHYS 201-1 Physics Undergraduate Seminar to the Lower Division Requirements.
   Rationale: All students will benefit from the cohort building of our new seminar. See Motion 1.
   b) To remove PHYS 421 as a required course.

Rationale: PHYS 421 is typically considered a course needed for graduate preparation and is not required in the PHYS major itself. Although relevant for all Physicists, material in 421 is not deemed more relevant to Chemical Physics.

Applied Physics Honours

Program Requirements
Students complete ~~132~~ 121 units, as specified below.

Lower Division Requirements

Students complete a minimum total of ~~54~~ 55 units, including all of
    CHEM 126 - General Chemistry Laboratory II (2)
    ~~CMPT 102 - Introduction to Scientific Computer Programming (3)~~
    ~~CMPT 150 - Introduction to Computer Design (3)~~
    ~~CMPT 250 - Introduction to Computer Architecture (3)~~
    MATH 251 - Calculus III (3)
    MATH 252 - Vector Calculus (3)
    PHYS 132 - Physics Laboratory I (1) *
    PHYS 133 - Physics Laboratory II (1) *
    PHYS 201 – Physics Undergraduate Seminar (1)
    PHYS 211 - Intermediate Mechanics (3)
    PHYS 231 - Physics Laboratory II (3)
    PHYS 233 - Physics Laboratory III (2)
    PHYS 255 - Vibrations and Waves (3)
    PHYS 285 - Introduction to Relativity and Quantum Mechanics (3)
                        ⋮

and 9 units chosen from
    MACM 101 - Discrete Mathematics I (3)
    CMPT 102 - Introduction to Scientific Computer Programming (3)
    CMPT 120 - Introduction to Computing Science and Programming I (3)
    CMPT 125 - Introduction to Computing Science and Programming II (3)
    CMPT 127 - Computing Laboratory (3)
    CMPT 128 - Introduction to Computing Science and Programming for Engineers (3)
    or any 200-level CMPT course

Upper Division Requirements

Students complete a minimum total of 53 units, including all of
    MATH 310 - Introduction to Ordinary Differential Equations (3)
    PHYS 321 - Intermediate Electricity and Magnetism (3)
    PHYS 326 - Electronics and Instrumentation (4)
    PHYS 332W - Optics Laboratory (4)
    PHYS 344 - Thermal Physics (3)
    PHYS 384 - Methods of Theoretical Physics I (3)
    PHYS 385 - Quantum Mechanics I (3)
    PHYS 421 - Electromagnetic Waves (3)
    PHYS 431 - Advanced Physics Laboratory I (4)
    PHYS 432 - Undergraduate Honours Thesis (6) ++
    ~~PHYS 455 - Modern Optics (3)~~
    ~~PHYS 465 - Solid State Physics (3)~~

and a minimum of ~~11~~ 17 additional units chosen from
    CHEM 340 - Materials Chemistry (3)
    ENSC 426 - High Frequency Electronics (4)

ENSC 495 - Introduction to Microelectronic Fabrication (4) **
NUSC 341 - Introduction to Radiochemistry (3)
NUSC 346 - Radiochemistry Laboratory (2)
PHYS 365 - Semiconductor Device Physics (3)
PHYS 395 - Computational Physics (3) * or MACM 316 - Numerical Analysis I (3)
PHYS 455 - Modern Optics (3)
PHYS 465 – Solid State Physics (3)

Students considering physics graduate programs should also complete
PHYS 413 - Advanced Mechanics (3)
PHYS 415 - Quantum Mechanics II (3)
PHYS 445 - Statistical Physics (3)

Chemical Physics Honours

Program Requirements

Students complete ~~132~~ 123 units, as specified below.

Lower Division Requirements

Students are strongly encouraged to complete at least three lower division computing science units, in addition to the following requirements.

Students complete a minimum total of ~~59~~ 60 units, including all of
    CHEM 126 - General Chemistry Laboratory II (2)
    CHEM 215 - Introduction to Analytical Chemistry (4)
    CHEM 230 - Inorganic Chemistry (3)
    CHEM 236W - Inorganic Chemistry Laboratory (3)
    CHEM 266 - Physical Chemistry Laboratory I (2)
    CHEM 281 - Organic Chemistry I (4)
    MATH 251 - Calculus III (3)
    MATH 252 - Vector Calculus (3)
    PHYS 132 - Physics Laboratory I (1) *
    PHYS 133 - Physics Laboratory II (1)
    <u>PHYS 201 - Physics Undergraduate Seminar (1)</u>
    PHYS 211 - Intermediate Mechanics (3)
    PHYS 231 - Physics Laboratory II (3)
    PHYS 255 - Vibrations and Waves (3)
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Mathematical Physics Honours
Program Requirements
Students complete ~~132~~ 120 units, as specified below.

Lower Division Requirements

Students complete a minimum total of ~~46~~ 47 units, including all of
    MATH 242 - Introduction to Analysis I (3)
    MATH 251 - Calculus III (3)
    MATH 252 - Vector Calculus (3)
    PHYS 132 - Physics Laboratory I (1) *
    PHYS 133 - Physics Laboratory II (1) *
    <u>PHYS 201 – Physics Undergraduate Seminar (1)</u>
    PHYS 211 - Intermediate Mechanics (3)
    PHYS 231 - Physics Laboratory II (3)
    PHYS 233 - Physics Laboratory III (2)
    PHYS 255 - Vibrations and Waves (3)
    PHYS 285 - Introduction to Relativity and Quantum Mechanics (3)
    STAT 270 - Introduction to Probability and Statistics (3

Physics Honours

Program Requirements
Students complete ~~132~~ <u>120</u> units, as specified below.

Lower Division Requirements

Students complete a minimum total of ~~46~~ <u>47</u> units, including all of
 CMPT 102 - Introduction to Scientific Computer Programming (3)
 MATH 251 - Calculus III (3)
 MATH 252 - Vector Calculus (3)
 PHYS 132 - Physics Laboratory I (1) *
 PHYS 133 - Physics Laboratory II (1) *
 <u>PHYS 201 - Physics Undergraduate Seminar (1)</u>
 PHYS 211 - Intermediate Mechanics (3)
 PHYS 231 - Physics Laboratory II (3)
 PHYS 233 - Physics Laboratory III (2)
 PHYS 255 - Vibrations and Waves (3)
 PHYS 285 - Introduction to Relativity and Quantum Mechanics (3)
    ⋮

Upper Division Requirements

Students complete a minimum total of 52 units, including all of
 MATH 310 - Introduction to Ordinary Differential Equations (3)
 PHYS 321 - Intermediate Electricity and Magnetism (3)
 PHYS 332W - Optics Laboratory (4)
 PHYS 344 - Thermal Physics (3)
 PHYS 384 - Methods of Theoretical Physics I (3)
 PHYS 385 - Quantum Mechanics I (3)
 PHYS 413 - Advanced Mechanics (3)
 PHYS 415 - Quantum Mechanics II (3)
 PHYS 421 - Electromagnetic Waves (3)
 PHYS 431 - Advanced Physics Laboratory I (4)
 PHYS 432 - Undergraduate Honours Thesis (6)
 PHYS 445 - Statistical Physics (3)

~~and at least nine units chosen from~~
 ~~PHYS 347 - Introduction to Biological Physics (3)~~
 ~~PHYS 390 - Introduction to Astrophysics (3)~~
 ~~PHYS 395 - Computational Physics (3)~~
 ~~PHYS 455 - Modern Optics (3)~~
 ~~PHYS 465 - Solid State Physics (3)~~
 ~~PHYS 485 - Particle Physics (3)~~
 ~~PHYS 490 - General Relativity and Gravitation (3)~~

and ~~three~~ <u>twelve</u> additional upper division credits in physics. PHYS 346 cannot be used to meet this requirement

Biological Physics Honours

Program Requirements
Students complete ~~132~~ 126 units, as specified below.

Lower Division Requirements

Students complete a minimum total of ~~64~~ 65 units, including all of
    BISC 101 - General Biology (4)
    BISC 102 - General Biology (4)
    BISC 202 - Genetics (3)
    CHEM 281 - Organic Chemistry I (4)
    CHEM 282 - Organic Chemistry II (2)
    MATH 251 - Calculus III (3)
    MATH 252 - Vector Calculus (3)
    MBB 222 - Molecular Biology and Biochemistry (3)
    MBB 231 - Cellular Biology and Biochemistry (3)
    PHYS 201 – Physics Undergraduate Seminar (1)
    PHYS 211 - Intermediate Mechanics (3)
    PHYS 231 - Physics Laboratory II (3)
    PHYS 255 - Vibrations and Waves (3)
                        ⋮

Upper Division Requirements

Students complete a minimum total of ~~55-57~~ 49 units, including all of
    MATH 310 - Introduction to Ordinary Differential Equations (3)
    ~~MBB 309W - Biochemistry Laboratory (4)~~
    MBB 322 - Molecular Physiology (3)
    MBB 331 - Molecular Biology (3)
    PHYS 321 - Intermediate Electricity and Magnetism (3)
    PHYS 347 - Introduction to Biological Physics (3)
    PHYS 385 - Quantum Mechanics I (3)
    PHYS ~~433~~ 433W - Biological Physics Laboratory (4)
and one of
    CHEM 360 - Thermodynamics and Chemical Kinetics (3)
    MBB 323 - Introduction to Physical Biochemistry (3)
    PHYS 344 - Thermal Physics (3)
and ~~four~~ two other upper division MBB or PHYS courses. MATH 462 may be included in these two. The following courses are suggested.
    MATH 462 - Fluid Dynamics (3)
    MBB 308 - Molecular Biology Laboratory (3)
    MBB 309W - Biochemistry Laboratory (4)
    MBB 321 - Intermediary Metabolism (3)
    MBB 342 - Introductory Genomics and Bioinformatics (3)
    MBB 421 - Nucleic Acids (3)
    MBB 422 - Biomembranes (3)
    MBB 423 - Protein Structure and Function (3)
    ~~MBB 441 - Bioinformatics (3)~~
    ~~MBB 442 - Proteomics (3)~~
    PHYS 395 - Computational Physics (3)
    PHYS 413 - Advanced Mechanics (3)

PHYS 445 - Statistical Physics (3)
PHYS 455 - Modern Optics (3)
PHYS 492 - Special Topics in Physics (3)

Option A or B
In addition to the requirements stated above, students also complete the requirements for their choice of either Option A or Option B as stipulated below.

OPTION A
Students who choose this option will complete all of
MBB 309W - Biochemistry Laboratory (4)
MBB 481 - Individual Study Semester - Research Design (5)
MBB 482 - Individual Study Semester - Research Performance (5)
MBB 483 - Individual Study Semester - Research Reporting (5)

OPTION B
Students who choose this option will complete all of
PHYS 384 - Methods of Theoretical Physics I (3)
PHYS 415 - Quantum Mechanics II (3)
PHYS 421 - Electromagnetic Waves (3)
PHYS 432 - Undergraduate Honours Thesis (6)
PHYS 445 - Statistical Physics (3)

Applied Physics

Lower Division Requirements

Students complete a minimum total of ~~54~~ <u>55</u> units, including all of
    CHEM 126 - General Chemistry Laboratory II (2)
    ~~CMPT 102 - Introduction to Scientific Computer Programming (3)~~
    ~~CMPT 150 - Introduction to Computer Design (3)~~
    ~~CMPT 250 - Introduction to Computer Architecture (3)~~
    MATH 251 - Calculus III (3)
    MATH 252 - Vector Calculus (3)
    PHYS 132 - Physics Laboratory I (1) *
    PHYS 133 - Physics Laboratory II (1) *
    <u>PHYS 201 – Physics Undergraduate Seminar (1)</u>
    PHYS 211 - Intermediate Mechanics (3)
    PHYS 231 - Physics Laboratory II (3)
    PHYS 233 - Physics Laboratory III (2)
    PHYS 255 - Vibrations and Waves (3)
    PHYS 285 - Introduction to Relativity and Quantum Mechanics (3)
             :

<u>and 9 units chosen from</u>
    <u>MACM 101 - Discrete Mathematics I (3)</u>
    <u>CMPT 102 - Introduction to Scientific Computer Programming (3)</u>
    <u>CMPT 120 - Introduction to Computing Science and Programming I (3)</u>
    <u>CMPT 125 - Introduction to Computing Science and Programming II (3)</u>
    <u>CMPT 127 - Computing Laboratory (3)</u>
    <u>CMPT 128 - Introduction to Computing Science and Programming for Engineers (3)</u>
    <u>or any 200-level CMPT course</u>

Upper Division Requirements

Students complete a total of 36 units, including all of
    MATH 310 - Introduction to Ordinary Differential Equations (3)
    PHYS 321 - Intermediate Electricity and Magnetism (3)
    PHYS 326 - Electronics and Instrumentation (4)
    PHYS 332W - Optics Laboratory (4)
    PHYS 344 - Thermal Physics (3)
    PHYS 385 - Quantum Mechanics I (3)
    PHYS 421 - Electromagnetic Waves (3)
    ~~PHYS 455 - Modern Optics (3)~~

and ~~10~~ <u>13</u> units selected from
    <u>CHEM 340 - Materials Chemistry (3)</u>
    <u>ENSC 426 - High Frequency Electronics (4)</u>
    <u>ENSC 495 - Introduction to Microelectronic Fabrication (4) **</u>
    NUSC 341 - Introduction to Radiochemistry (3)
    NUSC 346 - Radiochemistry Laboratory (2)
    PHYS 365 - Semiconductor Device Physics (3)
    PHYS 395 - Computational Physics (3) + or MACM 316 - Numerical Analysis I (3)
    PHYS 431 - Advanced Physics Laboratory I (4)
    <u>PHYS 455 – Modern Optics (3)</u>
    PHYS 465 - Solid State Physics (3)

Biological Physics

Lower Division Requirements

Students complete a minimum total of ~~64~~ 65 units, including all of
    BISC 101 - General Biology (4)
    BISC 102 - General Biology (4)
    BISC 202 - Genetics (3)
    CHEM 281 - Organic Chemistry I (4)
    CHEM 282 - Organic Chemistry II (2)
    MATH 251 - Calculus III (3)
    MATH 252 - Vector Calculus (3)
    MBB 222 - Molecular Biology and Biochemistry (3)
    MBB 231 - Cellular Biology and Biochemistry (3)
    <u>PHYS 201 – Physics Undergraduate Seminar (1)</u>
    PHYS 211 - Intermediate Mechanics (3)
    PHYS 231 - Physics Laboratory II (3)
    PHYS 255 - Vibrations and Waves (3)
               :

Upper Division Requirements

Students complete a minimum total of 40 units, including all of
    MATH 310 - Introduction to Ordinary Differential Equations (3)
    ~~MBB 309W - Biochemistry Laboratory (4)~~
    MBB 322 - Molecular Physiology (3)
    MBB 331 - Molecular Biology (3)
    PHYS 321 - Intermediate Electricity and Magnetism (3)
    PHYS 347 - Introduction to Biological Physics (3)
    PHYS 385 - Quantum Mechanics I (3)
    PHYS ~~433~~ <u>433W</u> - Biological Physics Laboratory (3)
and one of
    CHEM 360 - Thermodynamics and Chemical Kinetics (3)
    MBB 323 - Introduction to Physical Biochemistry (3)
    PHYS 344 - Thermal Physics (3)
and ~~four~~ <u>five</u> other upper division MBB or PHYS courses. MATH 462 may be included amongst these four. The following courses are suggested.
    MATH 462 - Fluid Dynamics (3)
    MBB 308 - Molecular Biology Laboratory (3)
    <u>MBB 309W - Biochemistry Laboratory (4)</u>
    MBB 321 - Intermediary Metabolism (3)
    <u>MBB 342 - Introductory Genomics and Bioinformatics (3)</u>
    MBB 421 - Nucleic Acids (3)
    MBB 422 - Biomembranes (3)
    MBB 423 - Protein Structure and Function (3)
    ~~MBB 441 - Bioinformatics (3)~~
    ~~MBB 442 - Proteomics (3)~~
    PHYS 395 - Computational Physics (3)
    PHYS 413 - Advanced Mechanics (3)
    PHYS 445 - Statistical Physics (3)
    PHYS 455 - Modern Optics (3)
    PHYS 492 - Special Topics in Physics (3)

Physics

Lower Division Requirements

Students complete a minimum total of 46 units, including all of
    CMPT 102 - Introduction to Scientific Computer Programming (3)
    MATH 251 - Calculus III (3)
    MATH 252 - Vector Calculus (3)
    PHYS 132 - Physics Laboratory I (1) *
    PHYS 133 - Physics Laboratory II (1) *
    <u>PHYS 201 – Physics Undergraduate Seminar (1)</u>
    PHYS 211 - Intermediate Mechanics (3)
    PHYS 231 - Physics Laboratory II (3)
    PHYS 233 - Physics Laboratory III (2)
    PHYS 255 - Vibrations and Waves (3)
    PHYS 285 - Introduction to Relativity and Quantum Mechanics (3)
              ⋮

Chemical Physics

Lower Division Requirements

Students are strongly encouraged to complete at least three lower division computing science units, in addition to the following requirements.

Students complete a minimum total of 59 60 units, including all of
    CHEM 126 - General Chemistry Laboratory II (2)
    CHEM 215 - Introduction to Analytical Chemistry (4)
    CHEM 230 - Inorganic Chemistry (3)
    CHEM 236W - Inorganic Chemistry Laboratory (3)
    CHEM 266 - Physical Chemistry Laboratory I (2)
    CHEM 281 - Organic Chemistry I (4)
    MATH 251 - Calculus III (3)
    MATH 252 - Vector Calculus (3)
    PHYS 132 - Physics Laboratory I (1) *
    PHYS 133 - Physics Laboratory II (1)
    <u>PHYS 201 – Physics Undergraduate Seminar (1)</u>
    PHYS 211 - Intermediate Mechanics (3)
    PHYS 231 - Physics Laboratory II (3)
    PHYS 255 - Vibrations and Waves (3)
                    ⋮

Upper Division Requirements

Students complete a minimum total of 40 units, including all of
    CHEM 340 - Materials Chemistry (3)
    CHEM 462 - Molecular Spectroscopy (3)
    MATH 310 - Introduction to Ordinary Differential Equations (3)
    PHYS 321 - Intermediate Electricity and Magnetism (3)
    ~~PHYS 421 - Electromagnetic Waves (3)~~

and one of
    PHYS 326 - Electronics and Instrumentation (4)
    PHYS 332W - Optics Laboratory (4) **
and one of
    CHEM 360 - Thermodynamics and Chemical Kinetics (3)
    PHYS 344 - Thermal Physics (3)
and one of
    CHEM 460 - Advanced Physical Chemistry (3)
    PHYS 445 - Statistical Physics (3)
and one of
    CHEM 464 - Quantum Chemistry (3)
    PHYS 385 - Quantum Mechanics I (3)

and upper division chemistry, nuclear science or physics units chosen to total the number of upper division units to 40, and maintain a minimum of 15 upper division units in both chemistry and physics