UNDERGRADUATE HANDBOOK

Transfer Orientation
Summer 2018

FIRST-YEAR ADVISORS
Last name beginning with A-L: Patricia Amateis pamateis@vt.edu

Last name beginning with M-Z: Jeannine Eddleton jeddleton@vt.edu

General Advising: Amy Kokkinakos amyk@vt.edu
# Table of Contents

**Introduction**  
1

**Minimum Grade Requirement**  
2

**Chemistry B.S. Checksheet**  
3  
Chemistry B.S. Recommended Schedule  
5

**Chemistry B.A. Checksheet**  
6  
Chemistry B.A. Recommended Schedule  
8

**Chemistry Minor Checksheet**  
9

**Important Waypoints to Graduation**  
10

**Chemistry Advising**  
11  
Advisor List

**Program Options for Chemistry Majors**  
12  
Chemistry Teacher Certification  
Office of Health Professions Advising  
Recommended CHEM B.A. schedule for Pre-med students

**Useful Information for the Undergraduate Catalog**  
13  
Academic Eligibility Policy  
Registration for Classes  
Course Loads  
Late Adds  
Class Level  
Enrollment in Graduate Courses  
Pass-Fail Grade Options  
Course Withdrawal Policy  
Repeated and Duplicate Courses  
Transfer Credit  
Double Majors & Second Degrees  
Minors  
Graduation  
Curriculum for Liberal Education (CLE)

**Honors Program**  
17

**Miscellaneous Student Information**  
18  
Undergraduate Research  
Chemistry Club & Alpha Chi Sigma  
After Graduation  
University Counseling  
Student Success Center  
Virginia Tech Policy Department  
Safe Ride

**Undergraduate Chemistry Courses**  
20
Introduction

Chemistry is central to the sciences, the understanding of the physical world, and the study of biological systems. Chemistry is the science of transformations and energetics of materials at the molecular level. Chemistry has applications from the nanoscale to the macroscopic. Chemists use their training and creativity to improve the quality of life by creating new drugs, inventing new materials, improving the efficiency of processes, developing new energy systems, and providing critical data for policy decisions. A chemistry degree provides a solid foundation to pursue a range of career directions spanning fundamental research, applied research tied closely to engineering or health professions, chemical education, and technical areas in business and law. Virginia Tech offers two course curricula leading to undergraduate degrees in Chemistry, the Bachelor of Science (B.S.) and the Bachelor of Arts (B.A.):

THE B.S. CURRICULUM
The curriculum leading to the B.S. degree in chemistry prepares students for careers as professional chemists in industry or government or to continue their academic training in graduate study in chemistry or related fields. It is also suitable to prepare for pre-professional school or high school teaching. The B.S. degree meets the guidelines of the American Chemical Society (ACS) for an ACS-certified degree in chemistry.

THE B.A. CURRICULUM
The B.A. curriculum allows greater flexibility to include more elective courses for students who wish to tailor a program to their individual goals, including pursuing a double major. It is also suitable for students interested in pursuing graduate study in an area related to chemistry, professional school, high school teaching with multiple endorsements, or business. In deciding to start either the B.A. or the B.S. degree, one major difference for freshman year is the different math courses in the two curricula. Due to the greater math requirements of the B.S., it is easier to start on the B.S. and switch to the B.A. rather than vice versa.

This handbook outlines the requirements to complete the Chemistry B.S. and B.A. degrees and provides answers to common questions that students have about choosing and completing a degree at Virginia Tech. There are two important notes to the information presented here: (1) the Virginia Tech Undergraduate Catalog is the official reference source on academic policies, and (2) this handbook includes the most current checksheets, however degree requirements can change and you should obtain the appropriate checksheet from the Chemistry Department website for your graduation term.

Thank you for choosing chemistry! For more information contact

Prof. Patricia Amateis                  Amy Kokkinakos
Director of Undergraduate Programs     Undergraduate Program Coordinator
109F Davidson Hall                     117B  Davidson Hall
540-231-6629                           540-231-4239
Email: pamateis@vt.edu                 Email: amyk@vt.edu

or visit the Chemistry Department’s Undergraduate Programs website:

http://www.chem.vt.edu/undergrad
Minimum grade requirements for Progress Towards Degree

For students who start at Virginia Tech as chemistry majors

**General Chemistry for Chemistry Majors CHEM 1055-1056**
First year chemistry majors are scheduled to take CHEM 1055-1056, General Chemistry for Majors lecture sequence, and the corresponding labs, CHEM 1065-1066. All chemistry majors must earn a “C” (2.0) or better in CHEM 1055 in the fall to take CHEM 1056 in the spring.

If a chemistry major fails to earn a “C” (2.0) or better in CHEM 1055, he or she must either retake this class (and earn the minimum grade) or take CHEM 1035-1036, General Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 1035-1036, a minimum grade of “B” (3.0) is required in both in order to enroll in CHEM 2565 and progress towards a chemistry degree.

**Principles of Organic Chemistry CHEM 2565-2566**
All chemistry (B.A. and B.S.) majors take the Principles of Organic Chemistry lecture sequence, CHEM 2565-2566. Chemistry majors must earn a “C” (2.0) or better in CHEM 1056 to take CHEM 2565. Chemistry majors must earn a “C” (2.0) or better in CHEM 2565.

Substituting “Non-Majors” credits—for students who transfer in or start at Virginia Tech as a major other than Chemistry

**General Chemistry CHEM 1035-1036**
Non-chemistry majors at Virginia Tech who have taken CHEM 1035-1036 and wish to transfer into chemistry to pursue a B.A or a B.S. must have earned a “B” (2.0) or better in each course to count them as General Chemistry for Chemistry Majors lectures CHEM 1055-1056.

There is no minimum grade requirement for non-chemistry majors to count credit for General Chemistry labs CHEM 1045-1046 as General Chemistry for Chemistry Majors labs CHEM 1065-1066.

Non-chemistry majors at Virginia Tech who have taken CHEM 2535 and wish to transfer into chemistry to pursue a B.A. or a B.S. must have earned a “B” (3.0) or better in this course to count it as Principles of Organic Chemistry lecture CHEM 2565.
PART 1: CURRICULUM FOR LIBERAL EDUCATION (CLE) REQUIREMENTS

CLE requirements and approved courses are available online:
http://www.cle.prov.vt.edu/guides/index.html

<table>
<thead>
<tr>
<th>PART 1:</th>
<th>CLE credit hour requirement: 24 credits</th>
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<tbody>
<tr>
<td>I. Writing and Discourse (Area 1: 6 credits + ViEWS)</td>
<td>(credit hours in parentheses)</td>
</tr>
<tr>
<td>ENGL 1105-1106 6 First-Year Writing &amp; ViEWS requirement</td>
<td>(3) , (3)</td>
</tr>
<tr>
<td>II. Ideas, Cultural Traditions, and Values (Area 2: 6 credits required)</td>
<td>(3) , (3)</td>
</tr>
<tr>
<td>(Select from approved CLE courses)</td>
<td></td>
</tr>
<tr>
<td>III. Society and Human Behavior (Area 3: 6 credits required)</td>
<td>(3) , (3)</td>
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<tr>
<td>(Select from approved CLE courses)</td>
<td></td>
</tr>
<tr>
<td>IV. Scientific Reasoning and Discovery (Area 4)</td>
<td></td>
</tr>
<tr>
<td>V. Quantitative and Symbolic Reasoning (Area 5)</td>
<td></td>
</tr>
<tr>
<td>VI. Creativity and Aesthetic Experience (Area 6: 3 credits required)</td>
<td>(3)</td>
</tr>
<tr>
<td>(Select from approved CLE courses; must be a three-credit course.)</td>
<td></td>
</tr>
<tr>
<td>VII. Critical Issues in a Global Context (Area 7: 3 credits required)</td>
<td>(3)</td>
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<tr>
<td>(Select from approved CLE courses)</td>
<td></td>
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</table>

PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS

<table>
<thead>
<tr>
<th>PART 2:</th>
<th>College and department credit hour requirement: 96 credits</th>
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</thead>
<tbody>
<tr>
<td>I. Chemistry Courses (47 credits)</td>
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</tr>
<tr>
<td>CHEM 1055-1056 6, 13 General Chemistry for Majors</td>
<td>(4) , (4)</td>
</tr>
<tr>
<td>CHEM 1065-1066 6, 10, 11 General Chemistry for Majors lab</td>
<td>(1) , (1)</td>
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<tr>
<td>CHEM 2154 6 Analytical Chemistry for Majors</td>
<td>(4)</td>
</tr>
<tr>
<td>CHEM 2164 6 Analytical Chemistry for Majors lab</td>
<td>(1)</td>
</tr>
<tr>
<td>CHEM 2424 Descriptive Inorganic Chemistry</td>
<td>(3)</td>
</tr>
<tr>
<td>CHEM 2565 1, 6, 12-2566 Principles of Organic Chemistry</td>
<td>(3) , (3)</td>
</tr>
<tr>
<td>CHEM 2555-2556 13 Organic Syn-Tech lab</td>
<td>(2) , (2)</td>
</tr>
<tr>
<td>CHEM 1004 Chemistry First Year Experience</td>
<td>(1)</td>
</tr>
<tr>
<td>CHEM 3615-3616 Physical Chemistry</td>
<td>(3) , (3)</td>
</tr>
<tr>
<td>CHEM 3625-3626 Physical Chemistry lab</td>
<td>(1) , (1)</td>
</tr>
<tr>
<td>CHEM 4014 Survey of Chemical Literature</td>
<td>(1)</td>
</tr>
<tr>
<td>CHEM 4114 Instrumental Analysis</td>
<td>(3)</td>
</tr>
<tr>
<td>CHEM 4124 Instrumental Analysis Lab</td>
<td>(1)</td>
</tr>
<tr>
<td>CHEM 4404 Physical Inorganic Chemistry</td>
<td>(3)</td>
</tr>
<tr>
<td>CHEM 4414 Inorganic Synthesis &amp; Techniques lab</td>
<td>(2)</td>
</tr>
<tr>
<td>II. Mathematics Courses (16 credits)</td>
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<tr>
<td>MATH 1114 6 Elementary Linear Algebra</td>
<td>(2)</td>
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<tr>
<td>MATH 1225-1226 6 Calculus of a Single Variable</td>
<td>(4) , (4)</td>
</tr>
<tr>
<td>MATH 2204 6 Introduction to Multivariable Calculus</td>
<td>(3)</td>
</tr>
<tr>
<td>MATH 2214 Introduction to Differential Equations</td>
<td>(3)</td>
</tr>
<tr>
<td>III. Physics Courses (8 credits)</td>
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</tr>
<tr>
<td>PHYS 2305-2306 Foundations of Physics I &amp; II (incl. lab)</td>
<td>(4) , (4)</td>
</tr>
<tr>
<td>IV. Technical Electives (12 credits)</td>
<td></td>
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<tr>
<td>BCHM 3114 or 4115 Biochemistry elective</td>
<td>(3)</td>
</tr>
<tr>
<td>STAT or CS course 14 Statistics or Computer Science elective</td>
<td>(3)</td>
</tr>
<tr>
<td>CHEM 4534, 4634, or 4424 Polymer chemistry elective</td>
<td>(3)</td>
</tr>
<tr>
<td>CHEM 4xxx 16 CHEM/BCHM/CHE elective</td>
<td>(3)</td>
</tr>
<tr>
<td>V. FREE ELECTIVES (sufficient to achieve 120 credit graduation requirement or more)</td>
<td></td>
</tr>
<tr>
<td>(<strong>) ____________ (</strong>) ____________ (<strong>) ____________ (</strong>) ____________</td>
<td></td>
</tr>
<tr>
<td>(<strong>) ____________ (</strong>) ____________ (<strong>) ____________ (</strong>) ____________</td>
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Tentative as of 6/14/18
Minimum Grade Requirement: Chemistry majors must earn a grade of “C” (2.0) or better in CHEM 1055, 1056, and 2565.

- If a chemistry major fails to earn a “C” (2.0) or better in CHEM 1055, the student must either retake this class (and earn the minimum grade) or take CHEM 1035-1036, General Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 1035-1036, a minimum grade of “B” (3.0) is required in both in order to enroll in CHEM 2565 and progress towards the B.S. degree.
- If a chemistry major fails to earn a “C” (2.0) or better in CHEM 2565, the student must either retake this class (and earn the minimum grade) or take CHEM 2535, Organic Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 2535, a minimum grade of “B” (3.0) is required to count CHEM 2535 as CHEM 2565 for the CHEM degree.

This checksheet has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. Please see your advisor or consult the Undergraduate Course Catalog for more information. Please note: Chemistry majors are expected to be “calculus ready” upon the start of their curriculum.

Credit hours and GPA requirements: Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes Introduction to Chemistry (CHEM 1015, 1016, 1025, 1026), Chemistry First-Year Experience (CHEM 1004), and Chemistry Problem Solving Skills. No more than 6 hours of CHEM 2974, 4974, and 4994 will be included in a student’s in-major GPA.

Effective Spring 2015, chemistry majors must maintain an in-major GPA of 2.0. If a chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

Foreign requirement: Students who did not successfully complete at least two years of a single foreign language or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog of details.

For “satisfactory progress towards degree,” these courses and their prerequisites must be completed by the time the student has attempted 72 hours.

1. Fulfilled by CHEM 4014 and CHEM 3626.
2. Fulfilled by PHYS 2305 and PHYS 2306.
3. Fulfilled by MATH 1225 and MATH 1226.
4. Prior credit for CHEM 1045 may be substituted for CHEM 1065.
5. Prior credit for CHEM 1046 may be substituted for CHEM 1066.

Effective Fall 2014, if a student has taken CHEM 2535 prior to adding a degree in chemistry, a minimum grade of “B” (3.0) or better is required in order to substitute CHEM 2535 as CHEM 2565.

Since CHEM 2545-2546 does not satisfy the prerequisite for CHEM 2556 (due to training on specific instrumentation), if a student adds a CHEM BS degree after completing CHEM 2545-2546, two or more credits of CHEM 4994 may substitute for CHEM 2556 to meet the requirement of 400 lab hours beyond general chemistry for an ACS-approved degree.

Any three-credit STAT or CS course, with the exceptions of CS 1004 and CS 1xxx, may satisfy STAT/CS requirement for chemistry degree.

SBIO 3444 or SBIO 4424 (cross-listed with CHEM 4424) may count as polymer chemistry elective or upper-level restricted chemistry elective.

A biochemistry or chemical engineering student should not double-count coursework required for that major towards the chemistry upper-level elective.

Updated November 2017
# Bachelor of Science (B.S.) in Chemistry

## RECOMMENDED SCHEDULE

<table>
<thead>
<tr>
<th>First Year</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>CHEM 1055, 1056</td>
<td>General Chemistry for Majors</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 1065, 1066</td>
<td>General Chemistry for Majors Lab</td>
<td>1</td>
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<tr>
<td>CHEM 2984</td>
<td>Chemistry First Year Experience</td>
<td>1</td>
</tr>
<tr>
<td>ENGL 1105, 1106</td>
<td>First-Year Writing</td>
<td>3</td>
</tr>
<tr>
<td>MATH 1114</td>
<td>Elementary Linear Algebra</td>
<td>-</td>
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<tr>
<td>MATH 1225, 1226</td>
<td>Calculus for the Sciences</td>
<td>4</td>
</tr>
<tr>
<td>Elective</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td><strong>Semester Total</strong></td>
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<td>14</td>
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<table>
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<tr>
<th>Second Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 2154</td>
<td>Analytical Chemistry for Chem Majors</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 2164</td>
<td>Analytical Chemistry for Chem Majors Lab</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 2565, 2566</td>
<td>Principles of Organic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 2555</td>
<td>Organic Synthesis &amp; Techniques Lab</td>
<td>-</td>
</tr>
<tr>
<td>CHEM 4014</td>
<td>Survey of the Chemical Literature</td>
<td>-</td>
</tr>
<tr>
<td>CHEM 2424</td>
<td>Descriptive Inorganic Chemistry</td>
<td>-</td>
</tr>
<tr>
<td>MATH 2204</td>
<td>Multivariable Calculus for the Sciences</td>
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</tr>
<tr>
<td>MATH 2214</td>
<td>Introduction to Differential Equations</td>
<td>-</td>
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<tr>
<td>PHYS 2305, 2306</td>
<td>Foundations of Physics</td>
<td>4</td>
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<td><strong>Semester Total</strong></td>
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<tr>
<th>Third Year</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>CHEM 2556</td>
<td>Organic Synthesis &amp; Techniques Lab</td>
<td>2</td>
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<tr>
<td>CHEM 3615, 3616</td>
<td>Physical Chemistry</td>
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<tr>
<td>CHEM 3625</td>
<td>Physical Chemistry Lab</td>
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</tr>
<tr>
<td>CHEM 4114</td>
<td>Instrumental Analysis</td>
<td>-</td>
</tr>
<tr>
<td>BCHM 3114 or 4115</td>
<td>Biochemistry elective</td>
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<tr>
<td>STAT or CS xxxx</td>
<td>Statistics or Computer Science (not CS 1004 nor CS 1xxx)</td>
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<tr>
<td>Electives</td>
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<tr>
<td><strong>Semester Total</strong></td>
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<th>Fourth Year</th>
<th>Fall</th>
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<tbody>
<tr>
<td>CHEM 3626</td>
<td>Physical Chemistry Lab</td>
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<tr>
<td>CHEM 4124</td>
<td>Instrumental Analysis Lab</td>
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</tr>
<tr>
<td>CHEM 4404 *</td>
<td>Physical Inorganic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 4414 *</td>
<td>Inorganic Synthesis &amp; Techniques Lab</td>
<td>-</td>
</tr>
<tr>
<td>CHEM 4534/4634/4424</td>
<td>Polymer chemistry elective</td>
<td>3</td>
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<tr>
<td>CHEM 4xxx</td>
<td>CHEM/BCHM/CHE elective, 3000-level or higher</td>
<td>Electives</td>
</tr>
<tr>
<td><strong>Semester Total</strong></td>
<td>14</td>
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* An alternative to CHEM 4404 and 4414 is 4534 and 4074

Updated November 2017
PART 1: CURRICULUM FOR LIBERAL EDUCATION (CLE) REQUIREMENTS

(CLE requirements and approved courses are available online: http://www.cle.prov.vt.edu/guides/index.html) (credit hours in parentheses)

I. Writing and Discourse (Area 1: 6 credits + ViEWS)
ENGL 1105-1106 6 First-Year Writing (3) _____, (3) _____
& ViEWS requirement 7 (3) _____

II. Ideas, Cultural Traditions, and Values (Area 2: 6 credits required) (3) _____, (3) _____

III. Society and Human Behavior (Area 3: 6 credits required) (3) _____, (3) _____

IV. Scientific Reasoning and Discovery (Area 4) 8

V. Quantitative and Symbolic Reasoning (Area 5) 9

VI. Creativity and Aesthetic Experience (Area 6: 3 credits required) (3) _____
(Select from approved CLE courses; must be a three-credit course.)

VII. Critical Issues in a Global Context (Area 7: 3 credits required) (3) _____

PART 1: (CLE) credit hour requirement: 24 credits

PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS

I. Chemistry Courses (35 credits) 4
CHEM 1055-1056 1, 6 General Chemistry for Majors (4) _____, (4) _____
CHEM 1065-1066 6, 10, 11 General Chemistry for Majors lab (1) _____, (1) _____
CHEM 2154 Analytical Chemistry for Majors (4) _____
CHEM 2164 Analytical Chemistry for Majors lab (1) _____
CHEM 2424 Descriptive Inorganic Chemistry (3) _____
CHEM 2565-2566 1, 12 Principles of Organic Chemistry (3) _____, (3) _____
CHEM 2545-2546 Organic Chemistry lab (1) _____, (1) _____
CHEM 2984 Chemistry First-Year Experience (1) _____
CHEM 4615-4616 13 Physical Chemistry for Life Sciences (3) _____, (3) _____
CHEM 3625 Physical Chemistry lab (1) _____
CHEM 4014 Survey of Chemical Literature (1) _____

II. Mathematics Courses (9 credits)
MATH 1025-1026 6, 14, 15 Elementary Calculus (3) _____, (3) _____
MATH 2024 16 Intermediate Calculus (3) _____

III. Physics Courses (8 credits)
PHYS 2205 17-2206 18 General Physics (3) _____, (3) _____
PHYS 2215 17-2216 18 General Physics Lab (1) _____, (1) _____

IV. Technical Electives (9 credits)
STAT or CS course 19 Statistics or Computer Science elective (3) _____, (3) _____
CHEM 3xxx-4xxx 20, 21 CHEM/BCHM/CHE electives (3) _____, (3) _____

V. FREE ELECTIVES (sufficient to achieve 120 credit graduation requirement or more)
( ) ____________ ( ) ____________ ( ) ____________ ( ) ____________
( ) ____________ ( ) ____________ ( ) ____________ ( ) ____________

PART 2: College and department credit hour requirement: 96 credits
MINIMUM GRADE REQUIREMENT: Chemistry majors must earn a grade of “C” (2.0) or better in CHEM 1055, 1056, and 2565.

- If a chemistry major fails to earn a “C” (2.0) or better in CHEM 1055, the student must either retake this class (and earn the minimum grade) or take CHEM 1035-1036, General Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 1035-1036, a minimum grade of “B” (3.0) is required in both in order to enroll in CHEM 2565 and progress towards the B.A. degree.
- If a chemistry major fails to earn a “C” (2.0) or better in CHEM 2565, the student must either retake this class (and earn the minimum grade) or take CHEM 2535, Organic Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 2535, a minimum grade of “B” (3.0) is required to count CHEM 2535 as CHEM 2565 for the CHEM degree.

This checksheet has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. The checksheet for 2020 will be approved by the University Registrar in 2018. Please see your advisor or consult the Undergraduate Course Catalog for more information. Please note: Chemistry majors are expected to be “calculus ready” upon the start of their curriculum.

Credit hours and GPA requirements: Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes Introduction to Chemistry (CHEM 1015, 1016, 1025, 1026), Chemistry First-Year Experience, and Chemical Problem Solving Skills. No more than 6 hours of CHEM 2974, 4974, and 4994 will be included in a student’s in-major GPA.

Effective Spring 2015, chemistry majors must maintain an in-major GPA of 2.0. If a chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

Foreign Language Requirement: Students who did not successfully complete at least two years of a single foreign language or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

For “satisfactory progress towards degree,” these courses and their prerequisites must be completed by the time the student has attempted 72 hours.

CHEM 4014 satisfies part of the chemistry ViEWS (Visual Expression, Writing and Speaking) requirement. Chemistry B.A. majors may take three credits of Undergraduate Research, CHEM 4994(H), and make a poster presentation to satisfy the remaining ViEWS requirement within chemistry. Other options for satisfying ViEWS are pursuing a second major, taking ENGL 3764 Technical Writing, and taking COMM 2004 Public Speaking.

Fulfilled by PHYS 2205, 2206, 2215, and 2215 or by PHYS 2305-2306.

Fulfilled by MATH 1025-1026 or by MATH 1225-1226.

Prior credit for CHEM 1045 may be substituted for CHEM 1065.

Prior credit for CHEM 1046 may be substituted for CHEM 1066.

Effective Fall 2014, if a student has taken CHEM 2535 prior to adding a degree in chemistry, a minimum grade of “B” (3.0) or better is required in order to substitute CHEM 2535 as CHEM 2565.

CHEM 3615 may be substituted for CHEM 4615.

MATH 1225 may be substituted for MATH 1025.

MATH 1226 (MATH 1225 prerequisite) may be substituted for MATH 1026.

MATH 2204 (MATH 1226 prerequisite) may be substituted for MATH 2024.

PHYS 2305 (MATH 1205 prerequisite) may be substituted for PHYS 2205 and PHYS 2215.

PHYS 2306 (MATH 1206 prerequisite) may be substituted for PHYS 2206 and PHYS 2216.

Any three-credit STAT or CS course, with the exception of CS 1004, may satisfy STAT/CS requirement for chemistry degree.

SBIO 3444 may be counted towards upper-level CHEM electives.

A biochemistry or chemical engineering student should not double-count coursework required for that major towards the chemistry upper-level elective.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1055, 1056</td>
<td>General Chemistry for Majors</td>
<td>4</td>
<td>4</td>
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<tr>
<td>CHEM 1065, 1066</td>
<td>General Chemistry for Majors Lab</td>
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<td>1</td>
</tr>
<tr>
<td>CHEM 2984</td>
<td>Chemistry First-Year Experience</td>
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<td>ENGL 1105, 1106</td>
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<td>MATH 1025, 1026</td>
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<td>Electives</td>
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<tbody>
<tr>
<td>CHEM 2154</td>
<td>Analytical Chemistry for Chem Majors</td>
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<td>Analytical Chemistry for Chem Majors Lab</td>
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<tr>
<td>CHEM 2565, 2566</td>
<td>Principles of Organic Chemistry</td>
<td>3</td>
<td>3</td>
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<td>CHEM 2545, 2546</td>
<td>Organic Chemistry Lab</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 4014</td>
<td>Survey of the Chemical Literature</td>
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<td>1</td>
</tr>
<tr>
<td>CHEM 2424</td>
<td>Descriptive Inorganic Chemistry</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2024</td>
<td>Intermediate Calculus</td>
<td>3</td>
<td>-</td>
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<tr>
<td>PHYS 2205, 2206</td>
<td>General Physics</td>
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<tr>
<td>PHYS 2215, 2216</td>
<td>General Physics Lab</td>
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<th>Course Title</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>CHEM 4615, 4616</td>
<td>Physical Chemistry for Life Sciences</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3625</td>
<td>Physical Chemistry Lab</td>
<td>-</td>
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<tr>
<td>STAT or CS</td>
<td>Statistics or Computer Science (not CS 1004)</td>
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<tr>
<td>Electives</td>
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<table>
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<th>Course Title</th>
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<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 4xxx, 4xxx</td>
<td>CHEM/BCHM/CHE Electives, 3000-level or higher</td>
<td>3</td>
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</tr>
<tr>
<td>Electives</td>
<td></td>
<td>12</td>
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<tr>
<td>Semester Total</td>
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</tbody>
</table>
College of Science
Department of Chemistry
CHEMISTRY MINOR CHECKSHEET
For students graduating in calendar year 2020
The Minor in Chemistry requires completion of 22 credit hours

I. Required Courses (19 hours)
CHEM 1035 1-1036 2 General Chemistry (3) ___ (3) ___
CHEM 1045 3-1046 4 General Chemistry Labs (1) ___ (1) ___
CHEM 2535-2536 Organic Chemistry (3) ___ (3) ___
CHEM 2545-2546 Organic Chemistry Labs (1) ___ (1) ___
CHEM 4615 Physical Chemistry for Life Sciences 5 (3) ___
(Additional prerequisites: MATH 2015, PHYS 2206)

II. Elective course (3 hours) (3) ___
Choose one course from this list:
   BCHM 3114 Biochem for Biotech
   or BCHM 4115 General Biochemistry
   or CHEM 2114 Analytical Chemistry*
   or CHEM 2154 Analytical Chemistry for CHEM majors*
   or CHEM 2424 Descriptive Inorganic Chemistry*
   or CHEM/SBIO 4424 Polysaccharide Chemistry
   or CHEM 4514 Green Chemistry
   or CHEM 4534 Organic Chemistry of Polymers
   or CHEM 4554 Drug Chemistry
   or CHEM 4616 Physical Chemistry for Life Sciences
      (Additional prerequisite: MATH 2016)
   or CHEM 4634 Polymer and Surface Chemistry
   or CHEM/CSES/ENSC 4734 Environmental Soil Chemistry
      (Additional prerequisites: CSES 3114, CSES 3124, CHEM 2114 or instructor approval)
   or CHEM 4994 Undergraduate Research (3 credits)
      (Requires permission of faculty research advisor and undergraduate research eligibility requirements)
   or SBIO 3444 Sustainable Biomaterials & Bioenergy

III. Total Credits Required
A minimum of 22 credit hours in chemistry courses must be completed. *Students are required to complete 6 credit hours of 3000-4000 level courses.

IV. Minimum GPA
All courses used to fulfill the minor will count toward the minor GPA, and the student’s overall GPA for these courses must be a 2.0 or higher.

Notes:
Acceptable substitutions are as follows:

1 CHEM 1055 or CHEM 1055H may be substituted for CHEM 1035.
2 CHEM 1056 or CHEM 1056H may be substituted for CHEM 1036.
3 CHEM 1065 may be substituted for CHEM 1045.
4 CHEM 1066 may be substituted for CHEM 1046.
5 CHEM 3615 (Pre: CHEM 1036 OR 1056 OR 1056H; PHYS 2306; and MATH 1205, 1206 & 2224) may be substituted for CHEM 4615.
IMPORTANT WAYPOINTS TO GRADUATION

Freshman year
● attend Orientation, choose math sequence
● attend advising sessions (Fall, Spring) and meet your academic advisor (Spring)

Sophomore year
● choose B.A. or B.S. organic lab sequence.

Beginning of Junior Year
● Download degree checksheet for your graduation year
● Apply for Degree on Hokie SPA
● Request DARS Report on Hokie SPA and review with your advisor

End of Junior Year
● add any minors or second majors before being within 30 credits of graduation
● Begin making hotel arrangements for out-of-town guests to attend graduation

Beginning of Senior Year
● Request a new DARS Report on Hokie SPA and review with your advisor

Senior Year (graduation semester)
● Request a new DARS Report on Hokie SPA and review with your advisor

Senior Year (2 months before Graduation)
● Review http://www.vt.edu/commencement for commencement dates, times and locations
● Visit Bookstore to purchase cap and gown, announcements, etc.

IMPORTANT EVENTS EACH SEMESTER

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of week 1</td>
<td>last day to add classes</td>
</tr>
<tr>
<td>End of week 6</td>
<td>last day to drop classes</td>
</tr>
<tr>
<td>Tuesday of week 9</td>
<td>course request opens for the next semester</td>
</tr>
<tr>
<td>Tuesday of week 10</td>
<td>course request closes for the next semester</td>
</tr>
<tr>
<td>Monday of week 14</td>
<td>Drop/Add opens for the next semester</td>
</tr>
<tr>
<td>Wednesday of week 15</td>
<td>last day to apply late withdrawal policy</td>
</tr>
<tr>
<td>Wednesday of week 15</td>
<td>end of classes</td>
</tr>
<tr>
<td>Thursday of week 15</td>
<td>reading day</td>
</tr>
<tr>
<td>Friday of week 15</td>
<td>final exams begin</td>
</tr>
</tbody>
</table>

!!! Check the calendar on the Registrar's website (http://www.registrar.vt.edu) for exact dates each semester.
Advising

ADVISORS
As future colleagues, the Chemistry Faculty wants and expects to know every chemistry major personally. You should, as you move through the program, make an effort to meet and know your professors; they are available for help and guidance. A complete and current faculty listing is found on the department website (www.chem.vt.edu). In addition, in their second semester at Virginia Tech, all undergraduate chemistry majors are assigned to a faculty member who serves as their permanent academic advisor. Students may schedule appointments directly with their advisors whenever questions or issues arise. Additionally, it is the student’s responsibility to contact their advisor during course request for each upcoming semester. For "emergency" advice when the advisor cannot be located, students should feel free to contact any other advisor from the list below:

Dr. Patricia Amateis  
109F Davidson Hall  
231-6629*  
pamateis@vt.edu

Dr. Shamindri Arachchige  
109C Davidson Hall  
231-4878  
arachsm@vt.edu

Dr. Michael Berg  
109A Davidson Hall  
231-6837  
bergm@vt.edu

Dr. Maggie Bump  
109D Davidson Hall  
231-4675  
mbedtls@vt.edu

Dr. Jeannine Eddleton  
117A Davidson Hall  
231-8228  
jeddleto@vt.edu

Dr. Joe Merola  
3109 Hahn Hall South  
231-4510  
jmerola@vt.edu

Dr. Amanda Morris  
480B Davidson Hall  
231-5585  
ajmorris@vt.edu

Dr. John Morris  
1101 Hahn Hall South  
231-2472  
jmorris@vt.edu

Dr. Brian Tissue  
1105 Hahn Hall South  
231-3786  
tissue@vt.edu

Dr. Gordon Yee  
2103 Hahn Hall South  
231-3090  
gyee@vt.edu

In addition to your assigned academic advisor, the Department provides advisors for special programs:

Freshman Advising  Dr. Patricia Amateis and Dr. Jeannine Eddleton
Transfer Student Advising  Dr. Patricia Amateis and Dr. Gordon Yee
Career Advisor**  Dr. Gordon Yee
Honors Advisors  Dr. Patricia Amateis and Dr. Gordon Yee
Pre-Med, Dental, and Veterinary  Dr. Michael Berg
Teacher Certification  Dr. Jeannine Eddleton

*All advisors’ telephone numbers are area code (540).

**All chemistry majors should interact at least once a year with Dr. Yee. However, it is especially critical that rising juniors and seniors discuss their goals and aspirations early in the Fall Semester. Successfully finding the right position after graduation requires proper planning and a coordinated campaign.

A final note on advising: Advice is just that - advice to you to help you make decisions. Your advisor will provide advice on what he or she thinks will serve you best. Our advisors have been through what you are going through so listen to them and then make decisions that are best for you. You will find that life is a journey full of expected and unexpected curves with many different paths - all different and none of them right or wrong.
PROGRAM OPTIONS FOR CHEMISTRY MAJORS

CHEMISTRY TEACHER CERTIFICATION

The teacher certification advisor for chemistry majors is Dr. Jeannine Eddleton. Dr. Eddleton’s office is in 117A Davidson, her email address is jeddleto@vt.edu, and her phone number is (540) 231-8228.

Students wishing to become high school chemistry teachers should pursue a B.A. degree in chemistry and then enter the fifth-year secondary science education licensure program offered by the School of Education:

http://www.soe.vt.edu/scied

OFFICE OF HEALTH PROFESSIONS ADVISING

Formerly housed in the office of University Honors in Hillcrest Hall, and for many years referred to as the pre-med and pre-dental program, pre-health advising not only has a new name, but also new leadership. The Department of Career Services (http://www.career.vt.edu), a department within the Division of Student Affairs (http://www.dsa.vt.edu), is now home to Virginia Tech’s Office of Health Professions Advising. The Office of Health Professions Advising is in the Smith Career Services building.

The pre-med, pre-dental, and pre-vet advisor for chemistry majors is Dr. Mike Berg.

Students who wish to go to medical or dental school will meet minimum admission requirements for most schools by adding freshman biology to either (B.A. or B.S.) Chemistry degree program. However, most students take additional biology and biochemistry courses. For an orderly progression through these courses, it is important that pre-med and pre-dental students take biology in their freshman year.

The next page shows a suggested program of study for chemistry students who plan to go to medical school. A pre-dentistry program of study would be very similar.

CHEMISTRY B.A. for PRE-MEDICAL PROFESSIONAL Students

SUGGESTED COURSE SEQUENCE

<table>
<thead>
<tr>
<th>First Year</th>
<th>Fall</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>CHEM 1055, 1056</td>
<td>General Chemistry for Chem Majors</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 1065, 1066</td>
<td>General Chemistry for Chem Majors Lab</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 1004</td>
<td>Chemistry First Year Experience</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 1105, 1106</td>
<td>Principles of Biology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 1115, 1116</td>
<td>Principles of Biology Lab</td>
<td>1</td>
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<tr>
<td>ENGL 1105, 1106</td>
<td>First-Year Writing</td>
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<tr>
<td>MATH 1025</td>
<td>Elementary Calculus</td>
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<td>MATH 1026</td>
<td>Elementary Calculus</td>
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<td>CHEM 2565, 2566</td>
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<td>3</td>
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<tr>
<td>CHEM 2545, 2546</td>
<td>Organic Chemistry Lab</td>
<td>1</td>
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<tr>
<td>BIOL 2604</td>
<td>General Microbiology</td>
<td>3</td>
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<tr>
<td>BIOL 2004</td>
<td>Genetics</td>
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Students desiring a second major in biochemistry should refer to the biochemistry department website for updated information (http://www.biochem.vt.edu/undergraduate/index.html).

Other electives should be chosen after consultation with the Office of Health Professions Advising. Students interested in pharmacy school can follow this sequence being sure to take other required electives, e.g., microeconomics and public speaking, per admission requirements of the pharmacy school(s) of interest.

Useful Information from the Undergraduate Catalog

The following information is a general summary of many academic policies. Refer to the complete text in the Undergraduate Course Catalog (http://www.undergradcatalog.registrar.vt.edu/) for full details.

ACADEMIC ELIGIBILITY POLICY

A GPA of 2.0 (a C average) overall and in-major is required for graduation. Any time your overall GPA falls below 2.0 you are placed on academic probation. A student on probation may take no more than 16 credits per semester. Probation is lifted when the cumulative GPA rises to 2.0. If your overall GPA remains above a 2.0 but your one-semester GPA is below a 2.0, you are placed on academic warning.

See the Undergraduate Catalog (linked above) for full requirements and conditions leading to academic warning, probation, and suspension.
REGISTRATION FOR CLASSES
Course Request (pre-registration) is a period in the middle of each semester during which students enrolled currently may select classes for the following semester. Prior to, or during, course request, you should plan your schedule, consult with your advisor, and utilize course request in Hokie SPA.

COURSE LOADS
A student is classified as "full-time" if enrolled for 12 credit hours in fall and spring semesters and/or 6 credits during a summer session. A normal course load is 15-17 hours per semester. Overloads (more than 19 hours per semester, 9 each summer session) require permission of your Academic Dean's office. Unless such permission has been obtained in advance, you will not be able to add more than the maximum number of credits per semester/summer session.

LATE ADDS
Adding a course to your schedule after the deadline requires permission of your Academic Dean.

CLASS LEVEL
A student must have received credit for at least 30 hours to be classified as a sophomore, at least 60 hours to be classified as a junior, and at least 90 hours to be classified as a senior.

ENROLLMENT IN GRADUATE COURSES
With permission of the instructor, chemistry majors may enroll in 5000-level chemistry courses. Chemistry majors wishing to take 5000-level courses in other departments must have the approval of the instructor and the Dean of the Graduate School.

PASS-FAIL GRADE OPTIONS
Students may take certain courses on a pass-fail basis, according to the following regulations:
1. No Curriculum for Liberal Education requirements or departmental requirements may be taken under the pass-fail option for chemistry majors.
2. Minimum credit hours already passed on graded courses must equal 30 with a minimum GPA = 2.50. (Does not apply for courses offered only on a pass-fail basis.)
3. Maximum number of pass-fail credits allowed = 10% of the requirements for graduation taken at Virginia Tech. For example, if a student takes 120 credits at Virginia Tech, 12 hours may be taken Pass-Fail. If a student takes only 90 credit hours at Virginia Tech (with 30 transfer credits), then only 9 (10% of 90) credits may be taken Pass-Fail.
4. For courses taken pass-fail, P or F is recorded on the student's transcript and credit is given if the grade is P. If the course is failed, the "F" is considered as an "F" received under the "A-F" grading system and is included in calculation of the GPA.
5. Pass-fail courses are normally non-transferable to other institutions.
6. No more than 2 courses may be taken pass-fail in any semester unless courses are offered only pass-fail.
COURSE WITHDRAWAL POLICY
Students may drop courses prior to the drop deadline and the course is removed from your transcript. The drop deadline is announced in each semester's Timetable. A maximum of three (3) courses may be dropped beyond the normal drop deadline date during a student's academic career at Virginia Tech, subject to the following stipulations:

1. Students must formally request to withdraw from a course by the last day of classes in that academic term.
2. Courses from which a student withdraws under the terms of this policy will appear on their transcript with a W. The W signifies that this policy was invoked; the reasons for its use are the (private) responsibility of the student.
3. A student's decision to invoke this policy is irrevocable and unappealable.
4. Withdrawals may not be employed to reduce or obviate any penalty otherwise accruing to students under the University Honor System.
5. Students may request withdrawal from any course, irrespective of the grade earned up to the point of the request.
6. To withdraw from a course, you must fill out a Course Withdrawal Form available from the College of Science administrative office or from http://www.science.vt.edu/student/forms/cw.pdf. The form must be signed by you, your advisor, and your academic dean.

REPEATED AND DUPLICATED COURSES
A course that partially or wholly duplicates another (already taken) course does not count toward graduation. Duplication of two courses does not necessarily mean that they are equivalent; rather, it means that there is sufficient material overlap that credit is not allowed for both. No credit will be given toward graduation for duplicated courses nor may duplicate courses be used for GPA enhancement, unless the grade in the course already taken is a C- or less. Students may repeat courses in which they received grades of C- or below. Both grades stay on the record and figure into the overall and in-major GPA, but the course hours count only once toward graduation. Transcripts will display all hours attempted whether or not they count toward graduation.

TRANSFER CREDIT
Students transferring to Virginia Tech from a community college may transfer as many as 60 credits. Those who transfer from a four-year college have no such limitation. However, all students graduating from Virginia Tech must complete at least 27 hours in residence. A student must take at least 27 of their last 45 hours at Virginia Tech. Also, chemistry majors and minors must take at least 25% of the required chemistry courses at Virginia Tech.

More information is available online at the University Registrar's website: http://www.registrar.vt.edu. Transfer students should also review the information in the online Transfer Guide: (http://www.tranguide.registrar.vt.edu/).

Students frequently wish to take summer school courses at other institutions for transfer back to Virginia Tech. The student should contact the college or university they wish to attend to determine what courses will be offered. An "Authorization to Take Courses Elsewhere" form should be obtained from the student’s primary major’s academic dean’s office. For students whose (primary) major is chemistry, the form may be found in the College of Science’s administrative office or from http://www.science.vt.edu/student/forms/index.html. The form must be returned to the Dean's office at least three weeks before matriculation at the other institution. Students who wait until the last part of the Spring semester to file this form may experience some delay. The transcript evaluator will determine whether the desired courses will transfer as expected, and approved copies are sent to the student and the student’s academic advisor. After the courses are completed, the student must request that an official transcript be sent to the University Registrar at Virginia Tech.
DOUBLE MAJORS and SECOND DEGREES
Students who complete the requirements for two majors within the same academic term are considered Double Majors. Students receive a diploma for the primary major (degree) and a double major certificate for the secondary major (double major).

Students may complete the requirements for a Second Degree in a different academic term. Students pursuing a Second Degree must complete an additional 30 credits over the minimum required for their first degree. Students will receive a separate diploma for each degree.

You should indicate on your Application for Degree on Hokie SPA if your secondary major should be a double major or a second degree.

MINORS
Any department that offers a major may offer a minor. If you desire a minor in a particular subject, contact the appropriate department for their requirements or ask your advisor. Note that Majors and Minors are supposed to be added before senior year.

GRADUATION
You should apply for your Degree on Hokie Spa during your junior year. You may then generate a Degree Audit Report System (DARS) report in Hokie Spa to review your record to see what requirements remain to be completed for graduation. Applying for your degree early ensures that you will have time to take courses that you may have overlooked, and it allows you and your advisor to correct the Registrar's analysis if errors are present. Finally, you should be advised that the Registrar's graduation analysis is not a binding contract. Do not assume that you are excused from a required course on the basis of error in DARS; the Registrar will eventually find the mistake and you will not graduate.
CURRICULUM FOR LIBERAL EDUCATION (CLE) &
UNIVERSITY AND COLLEGE OF SCIENCE REQUIREMENTS
1. No more than 60 hours in the major may be counted towards the total number of hours required for
   graduation.
2. Successful completion of English 1105 and 1106, or 1204H. Students who receive Advanced
   Standing (with credit) for 1105 take only 1106.
3. Proficiency in a foreign language equivalent to one year of university instruction. This requirement
   can be met in several ways:
   3.1. Completing the third year (Level III) of a language in high school.
   3.2. Completing two years each of two different foreign languages in high school (for College of
       Science majors).
   3.3. Completing the 1106 course in Chinese, French, German, Greek, Italian, Japanese, Latin,
       Portuguese, Russian, or Spanish, including any prerequisites.
       NOTE: Students who have not completed foreign language requirements in high school may
       not count these hours toward the 120 required for graduation.
   3.4. Passing an oral examination in a language not taught at Virginia Tech.
   3.5. Documenting that English is not your primary language (see Department of Foreign
       Languages & Literatures for obtaining documentation).
4. Six (6) hours of humanities (Area 2).
5. Six (6) hours of social sciences (Area 3).
6. Three (3) hours of fine arts (Area 6). (The College of Science at Virginia Tech requires three
   credits for Area 6; some colleges within the university have different requirements.)
7. Three (3) hours: Critical Issues in a Global Context (Area 7). Some Area 7 courses may also count
   for Areas 2 or 3.
8. No course may be used to fulfill more than one core area, except for courses that list Area 7 and
   another area. (Some courses are listed as counting as Area 2 or Area 6. These are either/or choices.
   However, a course listed as counting towards Area 2 and Area 7 may be counted towards both.)
9. Virginia Tech’s Curriculum for Liberal Education yearly guides are available online:
   http://www.cle.prov.vt.edu/.

The Honors Program

The goal of University Honors is to provide the student enhanced access to a great faculty and the
   tools to create an education second to no other among the nation’s elite.

The Chemistry Department is an active participant in the University Honors Program. We offer honors
   sections of several lecture courses to all students of the University, and we encourage our majors who are
   eligible to join the Honors Program and participate fully.

Additional information on Honors eligibility can found on Virginia Tech's University Honors website,
   http://www.univhonors.vt.edu/, or by calling the Honors Program office for more information or to
   schedule an appointment – (540) 231-4591.
Miscellaneous Student Information

UNDERGRADUATE RESEARCH (CHEM 4994)
Chemistry majors are strongly encouraged to undertake a research project in collaboration with at least one faculty member. Credit for this activity is obtained by enrolling in CHEM 4994 for those semesters (potentially including summers) in which the work is to be performed. Chemistry faculty can suggest either short-term (one semester) or long-term projects; in every case, undergraduate research projects are designed to meet the individual interests and needs of the student. An interested student should consult with a prospective research mentor at least several weeks prior to the academic term in which s/he wants to register for undergraduate research. The student and research mentor must complete the “Undergraduate Research” form, which is available on the College of Science forms web page (cos.vt.edu). Students need a minimum 2.0 in-major GPA, a minimum 2.5 overall GPA, and a minimum of 28 credit hours completed at Virginia Tech to enroll in CHEM 4994.

ALPHA CHI SIGMA & CHEMISTRY CLUB
There are two student groups affiliated with the Chemistry Department at Virginia Tech: Alpha Chi Sigma, the co-ed professional chemistry fraternity; and the Chemistry Club, a student affiliate chapter of the American Chemical Society. All chemistry majors are encouraged to join one and/or both of these groups. Activities include meetings, socials, tutoring, and hosting “illusion shows” and an end-of-the-year picnic for the department. For further information, please visit http://www.chem.vt.edu/general.php?page=orgs_ugrag

AFTER GRADUATION?
After receiving the B.S. or B.A. degree in chemistry, some students continue their education in professional or graduate school, and some take an entry-level job in chemistry or a related discipline.

Professional School Opportunities. Chemistry graduates may choose to pursue careers in dentistry, law, medicine, optometry, pharmacy, veterinary medicine, etc. Your academic advisor can direct you to numerous sources of information concerning professional school.

Graduate School. Many companies prefer to hire scientists with advanced degrees. B.S. and B.A. chemistry majors are qualified to enter graduate school and pursue the M.S. or Ph.D. degree in a surprisingly large number of areas, some of which we have listed here:

<table>
<thead>
<tr>
<th>Chemistry</th>
<th>Biochemistry</th>
<th>Chemical Engineering</th>
</tr>
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<tbody>
<tr>
<td>Textiles</td>
<td>Paper Chemistry</td>
<td>Environmental Engineering</td>
</tr>
<tr>
<td>Food Science</td>
<td>Toxicology</td>
<td>Medicinal Chemistry</td>
</tr>
<tr>
<td>Pharmacology</td>
<td>Pharmacy</td>
<td>Materials Engineering</td>
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<tr>
<td>Polymer Chemistry</td>
<td>Virology</td>
<td>Forensic Chemistry</td>
</tr>
<tr>
<td>Oceanography</td>
<td>Clinical Chemistry</td>
<td>Secondary Education</td>
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</tbody>
</table>

Your academic advisor should be able to advise you concerning graduate school, particularly in chemistry. If you are interested in an area unfamiliar to your advisor, s/he should be able to direct you to someone knowledgeable. Students wishing to go to graduate school should plan to take the Graduate Record Exam (GRE) in the fall of their senior year and should complete their applications in mid-January.
Employment. Finding a job requires work, perseverance, and a little luck, so you should plan to spend considerable time and effort in your search. If you sit back and wait for employers to come to you, you will not find a job! There are three primary sources of help for students interested in finding employment immediately after graduation: your academic advisor, the departmental career advisor, and the Office of Career Services, http://www.career.vt.edu/. Career Services offers a variety of useful options such as mock interviews, résumé critique sessions, group meetings and seminars, and on-campus interviewing opportunities.

UNIVERSITY COUNSELING CENTER (www.ucc.vt.edu)
The Cook Counseling Center offers short-term individual, couples, and group counseling for a variety of concerns. Students come in for counseling to help them with issues such as stress, depression, anxiety, loneliness, sexual concerns, academic motivation, and relationship problems. The Cook Counseling Center office and phoneline are open Monday-Friday, 8:00 am to 5:00 pm, at 540-231-6557. If you need emergency counseling outside normal business hours, assistance is available by calling 540-231-6444.

STUDENT SUCCESS CENTER (http://www.studentsuccess.vt.edu/)
The Student Success Center at Virginia Tech offers free academic support—such as tutoring and a wide variety of seminars and information sessions (including seminars on time management, honing test-taking and note-taking skills, and how to stay focused through the semester)—to undergraduate students.

VIRGINIA TECH POLICE DEPARTMENT (www.police.vt.edu)
The Virginia Tech Police Department is nationally accredited by the Commission on Accreditation for Law Enforcement Agencies Incorporated. Our police department strives to enhance the safety and quality of life for students, faculty, staff and visitors through effective law enforcement and proactive crime prevention in partnership with the university community.

Several programs are offered by the department, free of charge, to Virginia Tech students. Programs include the Student’s Police Academy, Self-Defense/Rape Aggression Defense System course, and VT C-CERT (Campus Community Emergency Response Team) training. Please visit the department’s website (www.police.vt.edu) for more information.

SAFE RIDE
The police department also sponsors a nighttime campus safety escort service known as Safe Ride. Safe Ride operates from dusk until dawn and provides transportation or a walking escort upon request. To use this service, call (540) 231-SAFE.
### Undergraduate Courses (CHEM)

1004: FIRST YEAR EXPERIENCE IN CHEM  
Orientation to the Chemistry Department and to the discipline of chemistry for chemistry majors and for individuals considering CHEM as a major, including transfer students. Resources for success, both generally as a college student and specifically as a chemistry major. Opportunities for mentoring, individual research and community involvement across the university and within the Chemistry Department. Exploration of career pathways for chemistry majors. Interconnections among professional practice, disciplinary progress, accepted standards for ethical use of information, principles of diversity and inclusion, and individual or personal value systems. Scientific communication, professional networking, and chemistry in the public eye.

1015-1016: INTRODUCTION TO CHEMISTRY  
For students enrolled in curricula other than science or engineering. Chemical principles applied to material, environmental, and life sciences. (Duplicates 1035-1036.) (3H,3C)

1025-1026: INTRODUCTION TO CHEMISTRY LABORATORY  
Accompanies 1015-1016, where lab work is required in a student's curriculum. Must be taken concurrently and in phase with lecture sequence, 1015-1016. In both semesters, experiments illustrate principles covered in lecture. (Duplicates 1045-1046.) Co: 1015 for 1025; 1016 for 1026. (3L,1C)

1035-1036: GENERAL CHEMISTRY  
Principles of the science, character of the elements and their more important compounds, solution of chemical problems, and important applications. (Duplicates 1015-1016.) (3H,3C)

1045-1046: GENERAL CHEMISTRY LAB  
Accompanies 1035-1036. Selected experiments illustrate principles taught in lecture. (Duplicates 1025-1026). Co: 1035 for 1045; 1036 for 1046. (3L,1C)

1055-1056: GENERAL CHEMISTRY FOR CHEMISTRY MAJORS  
In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry majors. Co: 1065 for 1055; 1066, 1066 for 1056. (4H,4C)

1055H-1056H: HONORS GENERAL CHEM FOR MAJORS  
More in-depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry majors. Co: 1065 for 1055H; 1066, 1066 for 1056H. (4H,4C)

1065-1066: GENERAL CHEMISTRY FOR CHEMISTRY MAJORS LAB  
Accompanies 1055-1056. Selected experiments illustrate principles taught in lecture. This class is restricted to chemistry majors. Co: 1055 for 1065; 1056 for 1066. (3L,1C)

2114: ANALYTICAL CHEMISTRY  
A first course in analytical chemistry. Topics covered include volumetric and gravimetric analysis, and elementary spectroscopy. Pre: 1036 or 1056. Co: 2124. (3H,3C)

2124: ANALYTICAL CHEMISTRY LABORATORY TECHNIQUES AND PRACTICE  
Practical introduction to wet methods of quantitative chemical analysis based on fundamental chemical principles. CHEM 2124 may be substituted for CHEM 3124. Pre: (1046 or 1066), 2114. Co: 2114. (3L,1C)

2154: ANALYTICAL CHEMISTRY FOR CHEMISTRY MAJORS  
A one-semester course in analytical chemistry emphasizing the principles of equilibrium with examples from acid-base, complexation, solubility, and redox chemistry. The course also introduces the principles of spectroscopic, electrochemical, and chromatographic instrumentation. Pre: 1036 or 1036H or 1056 or 1056H. Co: 2164. 4H,4C)
2164: ANALYTICAL CHEMISTRY FOR CHEMISTRY MAJORS LAB
A one-semester laboratory course in analytical chemistry that provides practical training in wet chemical methods, atomic and molecular spectroscopy, electrochemistry, and separations. Pre: 1046 or 1066. Co: 2154. (3L,1C)

2424: DESCRIPTIVE INORGANIC CHEMISTRY
Application of fundamental principles in a systematic study of bonding and reactivity of the elements and their compounds. Pre: 1036 or 1056. (3H,3C)

2514: SURVEY OF ORGANIC CHEMISTRY
Short course in fundamentals of organic chemistry with emphasis on nomenclature, isomerism, and properties of organic compounds. Compounds of importance to biology and biochemistry stressed. (Prior credit for 2535 precludes credit for this course.) One year of Chemistry required. (3H,3C)

2535-2536: ORGANIC CHEMISTRY
Structure, stereochemistry, reactions, and synthesis of organic compounds. Pre: 1036 or 1056 for 2535; 2535 or 2565 for 2536. (3H,3C)

2545-2546: ORGANIC CHEMISTRY LABORATORY
The laboratory accompanies lectures in organic chemistry 2535 and 2536. Pre: 1046 or 1066 for 2545; 2545, (2536 or 2566) for 2546. Co: 2535 or 2565 for 2545; 2536 for 2546. (3L,1C)

2555-2556: ORGANIC SYNTHESIS AND TECHNIQUES LAB
Synthesis and characterization of organic compounds using modern laboratory techniques. II Pre: 2566 for 2555; 2555 for 2556. (6L,2C)

2565-2566: PRINCIPLES OF ORGANIC CHEMISTRY
Organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses. Pre: 1036 or 1056 for 2565; 2565 for 2566. (3H,3C)

2565H-2566H: HONORS PHYSICAL CHEMISTRY
More in-depth study of organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses. (3H,3C)

2974: INDEPENDENT STUDY
Variable credit course.

2984: SPECIAL STUDY
Variable credit course.

3615-3616: PHYSICAL CHEMISTRY
Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partially duplicates 4615, cannot receive credit for both 3615 and 4615. I,II,III. Pre: (1036 or 1056), PHYS 2306, MATH 2224 for 3615; 3615, 1036, MATH 2214, (PHYS 2306 or PHYS 2176) for 3616. (3H,3C)

3615H-3616H: HONORS PHYSICAL CHEMISTRY
More in-depth study of principles of thermodynamics, kinetics, and quantum mechanics as applied to chemical equilibria, reactivity, and structure. Partially duplicates 4615, cannot receive credit for both 3615H and 4615. 3615H requires additional work; consult the instructor. I,II,III Pre: 1036, (PHYS 2306 or PHYS 2176) for 3615H; 3615, 1036, MATH 2214, (PHYS 2306 or PHYS 2176) for 3616H. (3H,3C)

3625-3626: PHYSICAL CHEMISTRY LABORATORY
Laboratory study of selected physico-chemical principles and methods. Data acquisition, data analysis, and report writing are stressed. I,II Pre: 3615 or 4615 for 3625; 3616, 3625, and 4014 for 3626. (3L,1C)
4014: SURVEY OF CHEMICAL LITERATURE
Use of the chemical literature as an aid to professional activities. I,II (1H,1C)

4074 (MSE 4544): LABORATORY IN POLYMER SCIENCE
Experimental techniques used in the synthesis of various linear polymers, copolymers, and crosslinked networks. Determination of polymer molecular weights and molecular weight distribution. Methods used in the thermal, mechanical, and morphological characterization of polymeric systems. Graduate students in chemistry, P/F only. Pre: 3616, 4534. (1H,3L,2C)

4114: INSTRUMENTAL ANALYSIS
Principles of instrumental methods including data analysis, phase equilibrium, spectroscopy, and electrochemistry. Applications of modern instrumentation to chemical analyses using chromatography, electrophoresis, atomic and molecular spectroscopy, potentiometry, and voltammetry. Note: Graduate students will not be expected to take the instrumental analysis lab 4124. Pre: 3616. (3H,3C)

4114H: HONORS INSTRUMENTAL ANALYSIS
More in-depth treatment of principles of instrumental methods including data analysis, phase equilibrium, spectroscopy, and electrochemistry. Applications of modern instrumentation to chemical analyses using chromatography, electrophoresis, atomic and molecular spectroscopy, potentiometry, and voltammetry. Note: Graduate students will not be expected to take the lab 4124. Pre: 3616. (3H,3C)

4124: INSTRUMENTAL ANALYSIS LABORATORY
Hands-on experience with modern instrumental methods of analysis. Experiments use spectroscopy, electrochemistry, and separations. Pre: 4114. (3L,1C)

4404: PHYSICAL INORGANIC CHEMISTRY
A study of spectroscopic, bonding, and structural properties of inorganic compounds. I Pre: CHEM 2424, 3616. (3H,3C)

4414: INORGANIC CHEMISTRY LAB
Synthesis and characterization of inorganic compounds using modern laboratory techniques. II Pre: CHEM 2424, 3616, and 4404. (6L,2C)

4514: GREEN CHEMISTRY
Green chemistry applies the principles of prevention of toxic and hazardous waste, and energy efficiency to real world chemical products and processes. Emphasis is on case studies, problem solving, and life cycle analysis. Pre: 2536 or 2566 (3H,3C).

4524: IDENTIFICATION OF ORGANIC COMPOUNDS
Structure determination of organic compounds by spectroscopic methods, with an emphasis on mass spectrometry and nuclear magnetic resonance. Course will emphasize problem-solving skills. I. Pre: (2536 or 2566), (3616 or 4616). (3H,3C)

4534: ORGANIC CHEMISTRY OF POLYMERS
Structure, synthesis, and basic characteristics of the major classes of polymerization reactions including step-growth (condensation) and chain growth (addition), free radical, and ionic mechanisms. Pre: 2536 or 2566. (3H,3C)

4554: DRUG CHEMISTRY
Structure, synthesis, and physiological effects of major classes of pharmaceutical agents including CNS depressants and stimulants, analgesics, anesthetics, cardiovascular agents, chemotherapeutic drugs, and oral contraceptives. II Pre: 2536 or 2566. (3H,3C)
4615-4616: PHYSICAL CHEMISTRY FOR THE LIFE SCIENCES
Principles of thermodynamics, chemical kinetics, and chemical bonding for students in the life sciences. 4615: Laws and applications of thermodynamics. 4616: Chemical kinetics and chemical bonding including spectroscopy. Partly duplicates 3615, cannot receive credit for 3615 and 4615. 4615 Pre: (4615) CHEM 1036 or 1056 or 1056H, MATH 1206 or 2015, and PHYS 2206 or 2306). 4616 Pre: CHEM 1036 or 1056 or 1056H, MATH 2016 or 2224 or 2214, and PHYS 2206 or 2306. (3H,3C)

4634 (MSE 4534): POLYMER AND SURFACE CHEMISTRY
Physical chemical fundamentals of polymers and surfaces including adhesives and sealants. II Pre: 3615 or 4615. (3H,3C)

4654: ADHESIVE AND SEALANT SCIENCE
Introduction to the fundamental and practical aspects of adhesives and sealants. Emphasis on synthesis of polymeric adhesive and sealant molecules, determination of physical properties of adhesives and sealants, chemical and physical characteristics of adherend surfaces, and mechanical behavior and durability of bonded systems – including metals, composites, polymers, and wood. I Pre: (3615 or 4615). (3H,3C)

4734 (CSES 4734) (ENSC 4734): ENVIRONMENTAL SOIL CHEMISTRY
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes. Pre: CSES 3114, CSES 3124, CHEM 2514 or CHEM 2535, CHEM 3114, MATH 2015. (3H,3C)

4754 (CSES 4754) (ENSC 4754): INSTRUMENTAL ANALYSIS FOR AGRICULTURAL AND ENVIRONMENTAL SCIENCES
Theory and principles of common analytical instruments and their applications to agriculture and environmental science research. Topics include atomic absorption and emission spectroscopy, spectrophotometric methods (UV, visible, luminescence, and automation), chromatography, ion-selective electrodes, and microwave digestion. Infrared spectroscopy, atomic ratio and molecular mass spectroscopy, nuclear magnetic resonance will also be included. Provides hands-on experience with modern analytical instruments. Prerequisites or graduate standing required. II Pre: CHEM 2114, 2124 or CHEM 2154, 2164 or CSES 3114, 3124). (3H,3L,4C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4984: SPECIAL STUDY: Physical Organic Chemistry

4984: SPECIAL STUDY: Bioorganic Chemistry

4984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: HONORS UNDERGRADUATE RESEARCH
Variable credit course.