

# SCIENCE, MATHEMATICS AND TECHNOLOGY: B.A., B.S.

Students of Science, Mathematics and Technology will explore the natural sciences (physics, chemistry and biology), mathematics, computer science and a range of technological, applied-science and health-related fields. Students will study the fundamental laws and concepts of their concentration, develop their knowledge of scientific methodology and learn the skills important for successful practice and communication, whether they are entering a new field or honing skills in their current occupation. Students will sharpen skills in critical reading and thinking, as, together with a faculty mentor, create a program to meet your specific needs and goals.

Degree programs in Science, Mathematics and Technology offer students the opportunity to develop individualized degree plans based on their intellectual, professional, and personal interests. General program guidelines can be found on the "Program Details" tab, and students will work with an academic mentor to choose courses that meet the guidelines and address each student's individual interests. Students can also work with their academic mentors to identify applicable transfer credit, prior college-level learning, and possible course equivalencies. Working with a mentor and using Empire State University's educational planning process, students can develop a specialized concentration in Science, Mathematics and Technology by following the general program guidelines as well as any applicable concentration guidelines. Students may also develop their own concentrations.

For more information about general undergraduate degree requirements, please visit Earning an Undergraduate Degree (<http://catalog.esc.edu/undergraduate/earning-undergraduate-degree/>).

For sample degree programs and other degree planning resources, please visit the Department of Computer Science and Technology (<https://www.sunyempire.edu/computer-science-tech/degree-planning-resources/>), Mathematics (<https://www.sunyempire.edu/mathematics/degree-planning-resources/>), or Natural Sciences (<https://www.sunyempire.edu/natural-sciences/degree-planning-resources/>) Degree Planning Resources web page.

## Please note:

- Empire State University does not offer degrees in engineering. You may study the mathematics and the theoretical sciences that comprise the traditional engineering curriculum, but the title of the degree cannot contain the word "engineering".
- In the sciences there are many opportunities for experimentation, research, and analytical work. These include virtual labs, courses with lab kits, field experience courses and residencies. Students can also engage in scientific internships and pursue college credit for prior learning in their fields. Students should be aware that they may need specific laboratory and/or field courses to meet entrance requirements for graduate studies; they should confirm such requirements with these institutions.

Taking individual courses as a nondegree nonmatriculated student also is possible and will offer you the same range and depth of courses and rigorous standards as matriculated undergraduate students.

These area of study guidelines address the broad needs of students interested in pursuing degrees in Science, Mathematics, and Technology.

Bachelor's degree programs must fully address five program outcomes, which align with the Empire State University Learning Goals.

Students must discuss in their rationale essay how each outcome is met in ways relevant to their field. Learning related to these outcomes can be demonstrated through coursework and prior learning.

Students should refer to the university's concentration guidelines for program outcomes specific to their fields. Otherwise, students must research their field and describe academic and professional expectations for their concentration in their rationale essay.

Knowledge in science, mathematics, and technology is continually evolving. Thus, degree programs should demonstrate currency in their fields. In addition, students are expected to develop life-long learning skills and engage in ongoing inquiry to acquire new knowledge and maintain currency.

Students earning degrees in Science, Mathematics, and Technology will achieve the following program outcomes:

## FOUNDATION #1: BREADTH AND DEPTH OF KNOWLEDGE

| Code         | Title  | Credits |
|--------------|--|---------|
| BIOL 1000    | Survey of Biology  | 4       |
| BIOL 1002    | Human Biology  | 4       |
| BIOL 1004    | Human Nutrition  | 4       |
| BIOL 1006    | Genomics & You   | 4       |
| or BIOL 1210 | Biology I: Lecture   |         |
| BIOL 1200    | Biology I with Lab   | 4       |
| or BIOL 1212 | Biology II: Lecture  |         |
| BIOL 1201    | Biology II with Lab  | 4       |
| BIOL 1204    | Introduction to Cell Biology & Genetics                            | 4       |
| BIOL 1205    | Introduction to Organismal Biology                                 | 4       |
| BIOL 1206    | Introduction to Population Biology                                 | 4       |
| or BIOL 1310 | Anatomy and Physiology I: Lecture                                  |         |
| BIOL 1304    | Anatomy & Physiology I with Lab                                    | 4       |
| or BIOL 1312 | Anatomy & Physiology II: Lecture                                   |         |
| BIOL 1305    | Anatomy & Physiology II with Lab                                   | 4       |
| BIOL 1400    | Evolution & Ecology  | 4       |
| BIOL 1402    | Introduction to Biological Anthropology                            | 4       |
| BIOL 1404    | Wildlife Conservation  | 4       |
| CHEM 1002    | Chemistry in Context   | 4       |
| or CHEM 1210 | Chemistry I: Lecture   |         |
| CHEM 1205    | Chemistry I with Lab   | 4       |
| or CHEM 1210 | Chemistry I: Lecture   |         |
| CHEM 1206    | Chemistry II with Lab  | 4       |
| or CHEM 1212 | Chemistry II: Lecture  |         |
| CHEM 3210    | Organic Chemistry I with Lab                                       | 4       |
| or CHEM 3220 | Organic Chemistry I  |         |
| CSCI 1010    | Introduction to Computers  | 4       |
| CSCI 1020    | Introduction to Networks   | 4       |
| CSCI 3000    | Computer Operations & Security                                     | 4       |
| CSCI 4000    | Advanced Computing Models: Virtualization Cloud & Mobile Computing | 4       |
| CSCI 4005    | Software Engineering   | 4       |
| CSCI 4015    | Theory of Computation  | 4       |
| ENSC 1000    | Earth Science  | 4       |

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|---|--|----------------|--------------|---|---|
| ENSC 1002   | Energy: The Issues & the Science                             | 4              | or BIOL 2210 | Inside the Animal Mind: Insights into Animal Behavior Ecology & Evolution | 4 |
| ENSC 1004   | Global Climate Change  | 4              | BIOL 2200    | Microbiology with Lab   | 4 |
| ENSC 1006   | Introduction to Ecology & Sustainability                     | 4              | or BIOL 2220 | Microbiology: Lecture   | 4 |
| ENSC 1200   | Environmental Science  | 4              | BIOL 2201    | Tropical Ecology  | 4 |
| ENSC 2000   | Principles of Environmental Sustainability                   | 4              | BIOL 2204    | Ethnobotany   | 4 |
| GEOL 1200   | Introduction to Geology                                      | 4              | BIOL 3200    | The Biology of Being Human  | 4 |
| GEOL 2200   | Historical Geology with Lab                                  | 4              | BIOL 3204    | Genetics  | 4 |
| GSCI 1000   | Integrated Sciences  | 4              | BIOL 3206    | Cell Biology  | 4 |
| GSCI 1004   | Introduction to Forensic Science                             | 4              | BIOL 3208    | Molecular Biology   | 4 |
| GSCI 1006   | The Science of Cooking                                       | 4              | BIOL 3210    | Biology of Microorganisms   | 4 |
| GSCI 1020   | Physical Science   | 4              | BIOL 3212    | Biology of the Brain  | 4 |
| GSCI 1500   | Science Colloquium   | 4              | BIOL 3214    | Human Physiology  | 4 |
| HSCI 1010   | Introduction to Epidemiology                                 | 4              | BIOL 3302    | Evolution   | 4 |
| HSCI 1200   | Medical Terminology  | 4              | BIOL 3304    | Conservation Biology  | 4 |
| INFS 2000   | Exploring the Disciplines: Information Systems: Introductory | 2              | BIOL 3306    | Ecology   | 4 |
| INFS 3010   | Database Systems   | 4              | BIOL 3308    | Plant Ecology   | 4 |
| INFT 2020   | Introduction to Digital Crime & Digital Terrorism            | 4              | BIOL 3310    | Tropical Ecology  | 4 |
| INFT 3010   | Advanced Digital Crime & Digital Terrorism                   | 4              | BIOL 3400    | Marine Biology  | 4 |
| INFT 3040   | Social Media Management                                      | 4              | BIOL 3404    | Primate Behavioral Ecology  | 4 |
| INFT 3050   | Systems Analysis & Design                                    | 4              | BIOL 3408    | Advanced Biological Anthropology  | 4 |
| INFT 4005   | Business Continuity Planning & Disaster Recovery             | 4              | BIOL 3502    | Cellular and Molecular Neuroscience                                       | 4 |
| INFT 4015   | Information Assurance  | 4              | BIOL 3602    | Phytochemistry  | 4 |
| MATH 1040   | Algebra  | 4              | BIOL 3604    | Plant Physiology  | 4 |
| MATH 1140   | Precalculus  | 4              | BIOL 4102    | Diseases of the Brain   | 4 |
| MATH 2015   | Mathematics for Game Programmers                             | 4              | BIOL 4206    | Immunology  | 4 |
| MATH 2140   | Calculus I   | 4              | BIOL 4310    | Aquatic Biology & Ecology   | 4 |
| MATH 2141   | Calculus II  | 4              | BIOL 4300    | Herpetology   | 4 |
| MATH 3005   | History of Mathematics: Advanced                             | 4              | BIOL 4302    | Animal Learning   | 4 |
| MATH 3010   | Linear Algebra   | 4              | BIOL 4304    | Ornithology   | 4 |
| MATH 3015   | Discrete Mathematics   | 4              | BIOL 4306    | Mammalogy   | 4 |
| MATH 3025   | Math Modeling  | 4              | BIOL 4308    | Marine Mammalogy  | 4 |
| MATH 3040   | Calculus III   | 4              | BIOL 4400    | Principles of Pharmacology  | 4 |
| MATH 3045   | Mathematical Proofs  | 4              | BIOL 4408    | Molecular Biotechnology   | 4 |
| MATH 3065   | Ordinary Differential Equations                              | 4              | BIOL 4410    | Plant Biotechnology   | 4 |
| MATH 4005   | Number Theory  | 4              | CHEM 3210    | Organic Chemistry I with Lab  | 4 |
| MATH 4010   | Abstract Algebra I: Group Theory                             | 4              | or CHEM 3220 | Organic Chemistry I   | 4 |
| MATH 4025   | Complex Variables  | 4              | CHEM 3221    | Organic Chemistry II  | 4 |
| MGIS 4005   | Information Security & Policy                                | 4              | CHEM 3300    | Physical Chemistry I  | 4 |
| PHYS 1000   | Conceptual Physics   | 4              | CHEM 3302    | Physical Chemistry II   | 4 |
| PHYS 1100   | Introductory Astronomy                                       | 4              | CHEM 3400    | Biochemistry  | 4 |
| or PHYS 1210  | Physics I: Lecture   | 4              | CHEM 4200    | Inorganic Chemistry I   | 4 |
| PHYS 1200   | Physics I with Lab   | 4              | CHEM 4201    | Inorganic Chemistry II  | 4 |
| or PHYS 1212  | Physics II: Lecture  | 4              | CHEM 4300    | Environmental Chemistry I   | 4 |
| PHYS 1201   | Physics II with Lab  | 4              | CHEM 4301    | Environmental Chemistry II  | 4 |
| <b>FOUNDATION #2: PROBLEM SOLVING AND CRITICAL THINKING</b> |  |                |              |   |   |
| <b>Code</b>   | <b>Title</b>   | <b>Credits</b> | CHEM 4400    | Biochemistry I  | 4 |
| BIOL 1402   | Introduction to Biological Anthropology                      | 4              | CHEM 4401    | Biochemistry II   | 4 |
| BIOL 1404   | Wildlife Conservation  | 4              | CSCI 1015    | Introduction to Database Design   | 4 |
| BIOL 2002   | Populations & Diseases                                       | 4              | CSCI 1020    | Introduction to Networks  | 4 |
| BIOL 2004   | Bioterrorism   | 2              | CSCI 1025    | Introduction to Programming: Visual Basic                                 | 4 |
| BIOL 2208   | Animal Behavior  | 4              | CSCI 2010    | Introduction to C++ & OOP   | 4 |

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|-----------|--|-----|
| CSCI 2015 | Introduction to Object-Oriented Programming: Java                  | 4   |
| CSCI 3000 | Computer Operations & Security                                     | 4   |
| CSCI 3005 | Computer Organization & Architecture                               | 4   |
| CSCI 4000 | Advanced Computing Models: Virtualization Cloud & Mobile Computing | 4   |
| ENSC 3000 | Meteorology  | 4   |
| ENSC 3002 | Global Climates  | 4   |
| ENSC 3004 | Dendrology   | 2   |
| ENSC 3006 | Natural Disasters  | 4   |
| ENSC 3008 | National Parks of the US: Geology Ecology & History                | 4   |
| ENSC 3200 | Urban Ecology  | 4   |
| ENSC 3202 | Forest Ecology   | 4   |
| ENSC 3300 | Soil Science   | 4   |
| ENSC 4202 | Biogeography   | 4   |
| ENSC 4600 | Ecology & Earth Systems Field Research                             | 4   |
| ENSC 4800 | Environmental Science Capstone                                     | 4   |
| GEOL 3200 | Geomorphology  | 4   |
| GEOL 3202 | Hydrology  | 4   |
| INFS 1000 | Computer Applications  | 4   |
| INFS 1002 | Computer Applications for Data Processing                          | 2   |
| INFS 2010 | Introduction to Data Management Tools                              | 4   |
| INFT 2020 | Introduction to Digital Crime & Digital Terrorism                  | 4   |
| INFT 3005 | Data Analytics   | 4   |
| INFT 3010 | Advanced Digital Crime & Digital Terrorism                         | 4   |
| INFT 3015 | Communications Technology Convergence                              | 4   |
| INFT 3025 | Data Communications & Networks                                     | 4   |
| INFT 3040 | Social Media Management  | 4   |
| INFT 3045 | Social, Professional & Ethical Issues in Computing                 | 4   |
| INFT 3055 | Technology for Digital Marketing                                   | 4   |
| INFT 3065 | Web Systems Development  | 4   |
| INFT 4020 | Technology in Mathematics Education                                | 4   |
| MATH 1000 | College Mathematics  | 4   |
| MATH 1005 | Contemporary Mathematics   | 4   |
| MATH 1025 | Quantitative Reasoning   | 4   |
| MATH 1040 | Algebra  | 3,4 |
| MATH 1050 | Mathematics for Business   | 4   |
| MATH 1065 | Statistics   | 4   |
| MATH 1100 | Introduction to Discrete Mathematics                               | 4   |
| MATH 1110 | Geometry   | 4   |
| MATH 1150 | Calculus for Business  | 4   |
| MATH 2005 | History of Mathematics: Introductory                               | 4   |
| MATH 2010 | Introduction to Proof & Logic                                      | 4   |
| MATH 2015 | Mathematics for Game Programmers                                   | 4   |
| MATH 3010 | Linear Algebra   | 4   |
| MATH 3015 | Discrete Mathematics   | 4   |
| MATH 3045 | Mathematical Proofs  | 4   |
| MATH 4005 | Number Theory  | 4   |
| MATH 4025 | Complex Variables  | 4   |
| MATH 4030 | Real Analysis  | 4   |
| MGIS 2000 | The Internet of Things (IoT) Essentials                            | 4   |

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|-------------------------|--|---|
| MGIS 3000               | Business Intelligence: Practices, Technologies, Management | 4 |
| MGIS 3005               | The Business of the Internet of Things (IoT)               | 4 |
| MGIS 3010/<br>BUSN 3122 | Management Information Systems                             | 4 |
| MGIS 4015               | Project Management in IT / IS                              | 4 |
| MGIS 4020               | IT Strategy and Innovations                                | 4 |

**FOUNDATION #3: METHODOLOGICAL, QUANTITATIVE, AND DIGITAL EXPERTISE**

| Code         | Title                               | Credits |
|--------------|-------------------------------------|---------|
| BIOL 2201    | Tropical Ecology                    | 4       |
| BIOL 2208    | Animal Behavior                     | 4       |
| or BIOL 2220 | Microbiology: Lecture               |         |
| BIOL 2400    | Plant Biology                       | 4       |
| BIOL 3200    | The Biology of Being Human          | 4       |
| BIOL 3204    | Genetics                            | 4       |
| BIOL 3206    | Cell Biology                        | 4       |
| BIOL 3208    | Molecular Biology                   | 4       |
| BIOL 3210    | Biology of Microorganisms           | 4       |
| BIOL 3212    | Biology of the Brain                | 4       |
| BIOL 3214    | Human Physiology                    | 4       |
| BIOL 3302    | Evolution                           | 4       |
| BIOL 3304    | Conservation Biology                | 4       |
| BIOL 3306    | Ecology                             | 4       |
| BIOL 3308    | Plant Ecology                       | 4       |
| BIOL 3310    | Tropical Ecology                    | 4       |
| BIOL 3400    | Marine Biology                      | 4       |
| BIOL 3404    | Primate Behavioral Ecology          | 4       |
| BIOL 3408    | Advanced Biological Anthropology    | 4       |
| BIOL 3502    | Cellular and Molecular Neuroscience | 4       |
| BIOL 3602    | Phytochemistry                      | 4       |
| BIOL 3604    | Plant Physiology                    | 4       |
| BIOL 4102    | Diseases of the Brain               | 4       |
| BIOL 4206    | Immunology                          | 4       |
| BIOL 4300    | Herpetology                         | 4       |
| BIOL 4302    | Animal Learning                     | 4       |
| BIOL 4304    | Ornithology                         | 4       |
| BIOL 4306    | Mammalogy                           | 4       |
| BIOL 4308    | Marine Mammalogy                    | 4       |
| BIOL 4400    | Principles of Pharmacology          | 4       |
| BIOL 4408    | Molecular Biotechnology             | 4       |
| BIOL 4410    | Plant Biotechnology                 | 4       |
| CHEM 3210    | Organic Chemistry I with Lab        | 4       |
| or CHEM 3220 | Organic Chemistry I                 |         |
| CHEM 3221    | Organic Chemistry II                | 4       |
| CHEM 3400    | Biochemistry                        | 4       |
| CHEM 3300    | Physical Chemistry I                | 4       |
| CHEM 3302    | Physical Chemistry II               | 4       |
| CHEM 4200    | Inorganic Chemistry I               | 4       |
| CHEM 4201    | Inorganic Chemistry II              | 4       |
| CHEM 4300    | Environmental Chemistry I           | 4       |
| CHEM 4301    | Environmental Chemistry II          | 4       |

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|-----------|--|---|---|---|----------------|
| CHEM 4400 | Biochemistry I   | 4 | MATH 1100                                   | Introduction to Discrete Mathematics                                      | 4              |
| CHEM 4401 | Biochemistry II  | 4 | MATH 1110                                   | Geometry  | 4              |
| CSCI 1015 | Introduction to Database Design                                      | 4 | MATH 1150                                   | Calculus for Business   | 4              |
| CSCI 1025 | Introduction to Programming: Visual Basic                            | 4 | MATH 2140                                   | Calculus I  | 4              |
| CSCI 2010 | Introduction to C++ & OOP  | 4 | MATH 2141                                   | Calculus II   | 4              |
| CSCI 2015 | Introduction to Object-Oriented Programming: Java                    | 4 | MATH 3010                                   | Linear Algebra  | 4              |
| CSCI 3005 | Computer Organization & Architecture                                 | 4 | MATH 3025                                   | Math Modeling   | 4              |
| CSCI 4005 | Software Engineering   | 4 | MATH 3040                                   | Calculus III  | 4              |
| CSCI 4015 | Theory of Computation  | 4 | MATH 3065                                   | Ordinary Differential Equations   | 4              |
| ENSC 3000 | Meteorology  | 4 | MATH 4005                                   | Number Theory   | 4              |
| ENSC 3002 | Global Climates  | 4 | MATH 4025                                   | Complex Variables   | 4              |
| ENSC 3004 | Dendrology   | 2 | MGIS 3000                                   | Business Intelligence: Practices, Technologies, Management                | 4              |
| ENSC 3006 | Natural Disasters  | 4 | MGIS 3005                                   | The Business of the Internet of Things (IoT)                              | 4              |
| ENSC 3008 | National Parks of the US: Geology Ecology & History                  | 4 | MGIS 3010/<br>BUSN 3122                     | Management Information Systems  | 4              |
| ENSC 3200 | Urban Ecology  | 4 | MGIS 4005                                   | Information Security & Policy   | 4              |
| ENSC 3202 | Forest Ecology   | 4 | MGIS 4015                                   | Project Management in IT / IS   | 4              |
| ENSC 3300 | Soil Science   | 4 | MGIS 4020                                   | IT Strategy and Innovations   | 4              |
| ENSC 4202 | Biogeography   | 4 |   |   |                |
| ENSC 4600 | Ecology & Earth Systems Field Research                               | 4 | <b>FOUNDATION #4: COMMUNICATION</b>         |   |                |
| ENSC 4800 | Environmental Science Capstone                                       | 4 | <b>Code</b>                                 | <b>Title</b>  | <b>Credits</b> |
| GEOL 3200 | Geomorphology  | 4 | BIOL 2208                                   | Animal Behavior   | 4              |
| GEOL 3202 | Hydrology  | 4 | or BIOL 2210                                | Inside the Animal Mind: Insights into Animal Behavior Ecology & Evolution |                |
| GSCI 2200 | GPS & The New Geography  | 4 | BIOL 2400                                   | Plant Biology   | 4              |
| GSCI 3200 | Geographic Information Systems                                       | 4 | BIOL 3502                                   | Cellular and Molecular Neuroscience                                       | 4              |
| GSCI 4200 | Materials Science  | 4 | BIOL 3604                                   | Plant Physiology  | 4              |
| HSCI 3200 | Health Informatics   | 4 | BIOL 4102                                   | Diseases of the Brain   | 4              |
| HSCI 4200 | Epidemiology   | 4 | BIOL 4302                                   | Animal Learning   | 4              |
| INFS 1000 | Computer Applications  | 4 | BIOL 4400                                   | Principles of Pharmacology  | 4              |
| INFS 2010 | Introduction to Data Management Tools                                | 4 | ENSC 1000                                   | Earth Science   | 4              |
| INFS 3010 | Database Systems   | 4 | ENSC 4600                                   | Ecology & Earth Systems Field Research                                    | 4              |
| INFT 1005 | Introduction to Web Publishing                                       | 4 | ENSC 4800                                   | Environmental Science Capstone  | 4              |
| INFT 2010 | Introduction to Web Publishing with Adobe Dreamweaver Creative Cloud | 4 | GEOL 3202                                   | Hydrology   | 4              |
| INFT 3005 | Data Analytics   | 4 | GSCI 1500                                   | Science Colloquium  | 4              |
| INFT 3015 | Communications Technology Convergence                                | 4 | INFT 3000                                   | Academic Planning / Technology and Society                                | 4              |
| INFT 3020 | Cyber Crime & Computer Forensics                                     | 4 | MATH 1140                                   | Precalculus   | 4              |
| INFT 3025 | Data Communications & Networks                                       | 4 | MATH 2005                                   | History of Mathematics: Introductory                                      | 4              |
| INFT 3030 | Human-Computer Interaction   | 4 | MATH 2010                                   | Introduction to Proof & Logic   | 4              |
| INFT 3035 | Project Management   | 4 | MATH 3005                                   | History of Mathematics: Advanced  | 4              |
| INFT 3050 | Systems Analysis & Design  | 4 | MATH 3045                                   | Mathematical Proofs   | 4              |
| INFT 3055 | Technology for Digital Marketing                                     | 4 | MATH 4010                                   | Abstract Algebra I: Group Theory  | 4              |
| INFT 3065 | Web Systems Development  | 4 | MATH 4030                                   | Real Analysis   | 4              |
| INFT 4005 | Business Continuity Planning & Disaster Recovery                     | 4 |   |   |                |
| INFT 4015 | Information Assurance  | 4 | <b>FOUNDATION #5: SOCIAL RESPONSIBILITY</b> |   |                |
| INFT 4020 | Technology in Mathematics Education                                  | 4 | <b>Code</b>                                 | <b>Title</b>  | <b>Credits</b> |
| MATH 1000 | College Mathematics  | 4 | BIOL 1404                                   | Wildlife Conservation   | 4              |
| MATH 1005 | Contemporary Mathematics   | 4 | BIOL 2000                                   | Bioethics in Modern Medicine  | 4              |
| MATH 1025 | Quantitative Reasoning   | 4 | BIOL 2002                                   | Populations & Diseases  | 4              |
| MATH 1050 | Mathematics for Business   | 4 | BIOL 2004                                   | Bioterrorism  | 2              |
| MATH 1055 | Mathematics for Elementary Teachers                                  | 4 | BIOL 2204                                   | Ethnobotany   | 4              |
| MATH 1065 | Statistics   | 4 | BIOL 3304                                   | Conservation Biology  | 4              |
|           |  |   | BIOL 3306                                   | Ecology   | 4              |

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|-----------|---|-----|
| BIOL 4700 | Contemporary Topics in Biology                      | 4   |
| ENSC 1002 | Energy: The Issues & the Science                    | 4   |
| ENSC 1004 | Global Climate Change                               | 4   |
| ENSC 1006 | Introduction to Ecology & Sustainability            | 4   |
| ENSC 2000 | Principles of Environmental Sustainability          | 4   |
| ENSC 3006 | Natural Disasters                                   | 4   |
| ENSC 3008 | National Parks of the US: Geology Ecology & History | 4   |
| ENSC 3304 | Environmental Health                                | 4   |
| ENSC 3200 | Urban Ecology                                       | 4   |
| ENSC 3302 | Sustainable Living: Food & Energy                   | 4   |
| ENSC 4200 | Contemporary Environmental Issues                   | 4   |
| ENST 3005 | Community Supported Agriculture                     | 4   |
| ENST 3010 | Sustainability & Agriculture                        | 4   |
| ENST 3015 | Iroquois Cultural Botany                            | 4   |
| HSCI 1010 | Introduction to Epidemiology                        | 4   |
| HSCI 4200 | Epidemiology  | 4   |
| INFT 2005 | Green Computing                                     | 4   |
| INFT 3000 | Academic Planning / Technology and Society          | 4   |
| INFT 3045 | Social, Professional & Ethical Issues in Computing  | 3,4 |
| MATH 2005 | History of Mathematics: Introductory                | 4   |
| MATH 3005 | History of Mathematics: Advanced                    | 4   |

- Foundation 1: Breadth and Depth of Knowledge, Students will be able to demonstrate a conceptual understanding of their field by articulating foundational knowledge, including key concepts, methodologies, and theories.
- Foundation 1: Breadth and Depth of Knowledge, Students will be able to demonstrate a conceptual understanding of their field by explaining how their program includes breadth of knowledge in their subject area.
- Foundation 1: Breadth and Depth of Knowledge, Students will be able to demonstrate a conceptual understanding of their field by demonstrating how their program progresses from introductory-level to advanced-level knowledge.
- Foundation 2: Problem Solving and Critical Thinking, Students will be able to demonstrate skills to analyze and solve unique situations and problems by designing, implementing, and evaluating strategies for answering open-ended questions for which solutions are not immediately evident.
- Foundation 2: Problem Solving and Critical Thinking, Students will be able to demonstrate skills to analyze and solve unique situations and problems by thinking critically and objectively about problems and identifying the best solutions.
- Foundation 3: Methodological, Quantitative, and Digital Expertise, Students will be able to demonstrate a working knowledge of investigative, quantitative, and technological approaches and skills to engage in their fields by applying the quantitative and technical skills necessary to engage in their fields.
- Foundation 3: Methodological, Quantitative, and Digital Expertise, Students will be able to demonstrate a working knowledge of investigative, quantitative, and technological approaches and skills to engage in their fields by evaluating information, analyzing data, and utilizing technologies relevant to their disciplines.
- Foundation 4: Communication, Students will be able to demonstrate the skills needed to communicate scientific, mathematical, and/or technical concepts to a variety of audiences.

- Foundation 5: Social Responsibility, Students will be able to demonstrate an awareness of the societal context in which science, mathematics, and technology operate by demonstrating a social awareness in order to understand the interplay between their field and society.
- Foundation 5: Social Responsibility, Students will be able to demonstrate an awareness of the societal context in which science, mathematics, and technology operate by applying ethical principles and evaluating the impact of activities and research on their field and on society.
- Foundation 5: Social Responsibility, Students will be able to demonstrate an awareness of the societal context in which science, mathematics, and technology operate by analyzing multiple issues including diversity, equity, sustainability, gender, or social justice in their field.

## Concentration Guidelines

Specific guidelines have been developed for concentrations in the following areas:

- Biology (p. 5)
- Chemistry (p. 6)
- Computer Science (p. 7)
- Environmental Science (p. 9)
- Information Systems (p. 10)
- Information Technology (p. 12)
- Mathematics (p. 6)
- Physics (p. 6)
- Technology (p. 15)

If you are interested in an area not listed here, please contact your mentor about designing your own concentration.

## Biology Concentration - For Students Matriculated On Or After Jan. 1, 2020

### I. Overview

Biology is among the broadest of science disciplines and as such lays a foundation for a multitude of career paths. Students with concentrations in Biology may seek employment in education; academic, clinical, or research fields; environment and ecology-related fields; and allied health science professions. Additionally, a Biology concentration could serve as the foundation for future graduate studies in a variety of occupations.

Biology is one of the core fields in the natural sciences and as such, Biology concentrations must fulfill the guidelines for the Science, Mathematics and Technology Area of Study. Concentrations in Biology include a range of approaches; however, they share a common core of knowledge and an approach to progression within the individualized specialization. Students interested in focusing on the life sciences without meeting the full expectation of these guidelines, should consider a different concentration title that accounts for their interests and degree plan (e.g., Studies in Biology).

### II. Degree Design

The study of biology involves four levels of analysis. The molecular level includes the expression of genetic information, the chemistry of macromolecules, and metabolism. The cellular level focuses on the structure and function of cells with nuclei (known as eukaryotic cells)

and cells without nuclei (known as prokaryotic cells). The level of the organism covers the form and function of animals and plants. Finally, the ecological level analyzes the evolution and diversity of organisms and their interactions in the natural world. Degree plans in Biology should have a holistic perspective which accounts for these levels of study.

The field of biology also draws upon knowledge in chemistry, physics, and mathematics. These supporting disciplines inform advanced level study in biology at all levels of analysis. Therefore, degree plans in Biology should include introductory study in each of these fields as discussed below.

### **A. Foundation Of Knowledge Biology**

To cover the breadth of biological theory discussed above, introductory biology is typically divided into a sequence of courses. The content of the introductory sequence, typically two courses, is expected to include the following: A) at the molecular level: DNA structure and replication, gene expression, respiration, and photosynthesis; B) at the cellular level: cell structure and function, the cell cycle, mechanisms of cell division, and modes of inheritance; C) at the organismal level: a survey of animal organ systems, plant form and reproduction, and regulation of homeostasis; D) at the ecological level: systematics and survey of biological taxa, evolutionary mechanisms, the function of populations, communities and ecosystems.

The two course Biology I and II with Laboratory sequence and the three course Introduction to Cell Biology and Genetics, Introduction to Organismal Biology, and Introduction to Population Biology sequence are both examples of acceptable sequences. Students should explain in their rationale essays how the sequence of introductory courses they select covers the content for foundational knowledge.

### **Chemistry**

The foundation in chemistry should include two courses of introductory chemistry and at least the first semester of organic chemistry. For example, the General Chemistry I and II, or Chemistry I and II with Laboratory sequences, and Organic Chemistry I will provide this knowledge. Students are encouraged to consider including a second course in organic chemistry in their degree plans (e.g., Organic Chemistry II) especially if they plan to pursue graduate studies.

### **Physics**

The foundation in physics should include a two-course sequence of introductory physics, such as Physics I and II with Laboratory or equivalent. Physics taught using either an algebra or calculus platform is acceptable.

### **Mathematics**

Biology programs should include a course that covers statistics and probability (or a course that can similarly assist with quantitative analyses) and the first semester of calculus. For example, Statistics and Calculus I will provide this knowledge. Calculus II is strongly recommended and becomes more important if a student is interested in graduate studies.

### **B. Advanced Level Knowledge**

Degree plans in Biology should include advanced level study in each of the four levels of analysis: molecular, cellular, organismal, and ecological.

To accomplish this goal, students should include in their programs at least one advanced level course in each area as follows:

A) at the molecular level: students are required to take Genetics or its equivalent. In addition, students may include in the degree programs other courses in this area such as Biochemistry, or Molecular Biology:

B) at the cellular level: students are required to take Cell Biology or its equivalent. Students may also include in their degree programs other courses in this area such as Biology of Microorganisms:

C) at the organismal level: students may choose from a variety of courses such as Biology of the Brain, Ornithology, Plant Ecology, Forest Ecology, Herpetology, or Mammalogy:

D) at the ecological level: students may choose from a variety of courses such as Animal Behavior, Evolution, Ecology, Marine Biology, or Conservation Biology.

The remaining advanced level studies in the concentration can be either focused in a single area of biology or distributed among the different areas according to the student's specific interests in biology or their professional goals.

Studies in different biological subjects often cover the same topics in different context. For example, the mechanism of cell division is addressed in courses in the areas of cell biology, genetics, zoology and botany. This overlap is advantageous; repetition allows the student to view the topic from several perspectives. The resultant integration permits the development of an understanding of the functional relatedness of living organisms and demonstrates the unity of the various disciplines within biology.

### **C. Research And Experimental Skills**

Students pursuing a biology concentration should learn problem-solving and research skills, as well as knowledge of basic experimental and application methodologies, including data collection and analysis. They should demonstrate this learning through the progression of courses and/or experiences.

The foundational courses in biology and chemistry should include opportunities for experimentation. For other natural science courses, research and experimental activities are encouraged. For introductory and advanced level knowledge, there are many ways in which research and analytical skills can be integrated into the course work. These include virtual labs, courses with lab kits, field experience courses and residencies. In addition, the student may plan to include an internship in the degree program, as well as assessment of prior learning knowledge for credit.

Students should be aware that they may need specific laboratory and/or field courses to meet entrance requirements for graduate studies.

### **III. Rationale**

In addition to addressing the guidelines for the Science, Mathematics and Technology Area of Study, students must explicitly discuss in their rationale essay how each of the above topics are incorporated in their degree program.

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## **Chemistry Concentration - For Students Matriculated On Or After Feb. 1993**

The science of chemistry is concerned in the broadest sense with the structure and "behavior" (properties and reactions) of the material world. On one end of the spectrum (atomic structure) it overlaps strongly with physics, while on the other end (biochemistry), it overlaps with biology.

Traditional disciplinary majors in chemistry typically include 32-40 credits of study in chemistry, and 16-24 credits in mathematics, computers and cognate sciences.

Concentration studies in chemistry should provide an understanding of the primary principles, concepts, facts and theories across the discipline.

**The concentration should include study in:**

- chemical structure
- synthesis
- dynamics
- analysis

In a traditional chemistry major this is accomplished by course work in general/inorganic, organic, analytical and physical chemistry.

**Chemistry is an experimental science; therefore, whatever the focus, the concentration should provide:**

- a working knowledge of chemical laboratory methods, including basic techniques and skills of careful quantitative measurement
- experience with application of the most commonly used instrumental methods and purification methods
- ability to present and interpret laboratory results in a clear and well-organized fashion

**Additional expectations:**

- **Some skill in mathematics and quantitative reasoning** is important for understanding chemistry and working in the discipline. At the very least, a good working knowledge of algebra is needed, as well as an understanding of the application of statistics to scientific measurement and some basic understanding of the fundamental concepts and principles of calculus. The amount of mathematics needed beyond this will depend on the focus of the concentration.
- **Fundamental knowledge of the topics usually covered in general physics** (including electricity and magnetism, electro-magnetic radiation, heat and energy and work) should be provided for in the degree program. Depending on the focus of the concentration, additional study or learning in physics, biology or other science areas may be important. History and philosophy of science can provide a useful broader perspective.
- **The computer** has become an essential tool for work in almost all areas of chemistry. At least basic proficiency in the use of a computer, as well as some understanding of its range of applications in chemistry (data collection, analysis and presentation, modeling, simulation and problem solving, information storage and retrieval) is important.
- **Progression and depth in the discipline** can be demonstrated by evidence of learning or additional studies across the discipline at the more advanced level, or by focused learning on selected areas or topics (e.g., physical organic chemistry, polymer chemistry, chemical thermodynamics, coordination chemistry, biochemistry, environmental chemistry, theoretical and quantum chemistry, etc.). Advanced laboratory experience should be included, and might be focused on one or more areas, such as physical chemistry measurement or synthetic methods including purification, separation and characterization methods, or analytical methods.
- **Familiarity with some of the major journals and primary literature of the discipline** should be provided for in the concentration. A final integrative study or research project provides an excellent

opportunity to develop or demonstrate skill in the use of this literature.

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## Computer Science Concentration - For Students Matriculated On Or After Jan. 2009

Computer science focuses on aspects of the computer field that have a well-defined set of abstract concepts and principles. The objective of a concentration in computer science is to demonstrate strong comprehension of those abstract concepts and principles — the theory of the field — and to implement, demonstrate and test this theory via computer. As a result, a concentration in computer science would be a good choice for someone interested mostly in algorithms, systems programming, or computer hardware design.

Computer science, as a disciplinary concentration, probably would not be the best choice for someone primarily interested in specific, real-world problem solving in the business world. For such individuals, concentrations in information systems, information technology, or computer studies generally would be more appropriate.

These recommendations for formulating concentrations in computer science are based on "Computing Curricula 2001: Computer Science" by the Joint Task Force on Computing Curricula: IEEE Computer Society and Association for Computing Machinery [1]. These are general guidelines; students must consider these guidelines from the perspective of their individual goals. For example, students considering graduate school should do further research into the expectations for preparation for graduate work.

### Mathematics

Mathematics forms the foundation for much of computer science. [2] Students are expected to develop facility with mathematical language and symbols.

Because of the central and prerequisite position of discrete mathematical ideas within the field of computer science, study of discrete math is required. If a student does not have prior learning in discrete mathematics, that student should consider appropriate mathematical preparation in an early contract (though not necessarily the first). In the study of discrete math, the student should acquire a working knowledge of:

- functions, relations and sets
- basic logic
- proof techniques
- basics of counting
- graphs and trees
- discrete probability

Additional studies commonly include linear algebra, calculus, or finite mathematics, although there are other possibilities. [3]

### Programming

Students are expected to develop their understanding of programming beyond the skill level (that is, beyond the particular commands and syntax of a specific language) and develop an understanding of the general principles and characteristics of programming and programming languages. This includes:

- algorithms and problem solving with an emphasis on fundamental data structures

- recursion
- object-oriented programming
- event-driven programming

At least some portion of a study should be devoted to object-oriented programming.

### Note About Coding

Computer programming is one step in the software-development process; it is the implementation of the solutions to problems. Within a computer-science degree, it is not an end unto itself. The implementation of a problem solution or an algorithm in a particular language is coding, and while coding is a valuable skill, the conceptual understanding of the principles involved in developing solutions and algorithms, implementing them via standard reproducible methods and explaining them clearly are as, or more, important than coding. Therefore, it would not be expected that students would have a large number of programming languages as the focus of their degree plan.

### Algorithms And Complexity

Computer science studies are expected to include the study of algorithms and complexity including:

- basic algorithmic analysis
- algorithmic strategies
- fundamental computing algorithms
- distributed algorithms
- basic computability

### Architecture, Organization, Operating Systems And Net-Centric Computing

Students are expected to demonstrate knowledge of:

- computer architecture and organization
- operating systems
- net-centric computing

### Software Engineering

Students should develop an understanding of software engineering that links theory with practice. Such study might include:

- software design
- using APIs (application programming interfaces)
- software tools and environment
- software processes
- software requirements and specifications
- software validation and reliability (quality)
- software evolution

**Note:** Systems analysis and design is different from software engineering and it is possible that students might develop a program that would include the former along with additional components to achieve the desired linking of theory and practice.

### Social And Professional Issues

The science, mathematics and technology area of study guidelines specify that, "a student's degree studies should provide an awareness of the wider context in which science and technology operate."

In the case of computer science, it is expected that such study would be focused on social and professional issues, which might include such topics as:

- social context of computing
- professional and ethical responsibility
- methods and tools of analysis of issues, risks and liabilities of computer-based systems
- intellectual property
- privacy
- civil liberties and history of computing
- other appropriate topics to be determined

### Additional Studies

Computer science concentrations might be strengthened by the inclusion of one or more of the following topics:

- human-computer interaction
- graphics and visual computing
- intelligent systems
- information management (including databases)
- computational science and numerical methods

While the above material constitutes general guidelines, students must consider these guidelines from the perspective of their individual goals. In particular, students going on to graduate school will need to review the expectations for mathematics and content such as theory of computation.

Students who will be seeking employment based on their computer science degree must review the current professional expectations for their intended career path. It should be noted that some knowledge not emphasized here, such as knowledge of information management and databases, is a common expectation. Similarly, some industries and professions have very specific expectations for specific programming languages.

Students should explicitly discuss in their rationale essay how each of the above foundation topics are incorporated and demonstrated in their degree program and how the program is designed to meet their goals. It is not necessary that the specific terms used above appear in individual study titles.

Endnote 1: [www.acm.org](http://www.acm.org) (<https://www.acm.org/>), accessed 7/20/06

Endnote 2: Students pursuing concentrations in computer science are assumed to have facility and confidence with algebra. Algebraic symbols are the language of all higher mathematics and the assumption is that students understand the meaning of algebraic expressions and can carry through algebraic computations with confidence. Students who do not have skill and confidence with algebra must address this issue very early in their program, before they undertake any study related to computing.

Endnote 3: The study of calculus has been the traditional method by which students have developed mathematical skills. Because of this tradition, there are usually several examples and some algorithms in advanced-level study which draw on ideas of calculus. So, studying calculus is still useful. But calculus is about continuous variables, while computers work with discrete variables. For that reason, topics such as linear algebra or finite math are usually more directly relevant to computing.



## Environmental Science Concentration - For Students Matriculated On Or After July 1, 2013

Environmental Science is a broad interdisciplinary study within Science, Mathematics and Technology, which draws upon the knowledge of biology, chemistry and physics to help learners explore and understand complex, dynamic processes operating within natural environmental systems. Within the concentration of Environmental Science, students may focus on specific themes such as agroecology, alternative energy, climate change, ecology, soil science, sustainability and water resources.

The interdisciplinary nature of the Environmental Science concentration offers many occupational possibilities. Possible career opportunities for students with concentrations in Environmental Science may include, but are not limited to environmental consulting, education, environmental law, research, positions with the Department of Environmental Conservation (DEC), resource management, restoration and conservation, watershed management and sustainable agriculture. This concentration also will prepare students for graduate school programs with focuses in the Environmental Sciences.

Students interested in focusing on human interactions with environmental systems, e.g., environmental policy, economics, education and communications, should consider a concentration in Environmental Studies rather than Environmental Science. This concentration can be developed within the Interdisciplinary Studies area of study.

Concentrations in Environmental Science include a range of approaches and titles; however, they share a common core of knowledge and an approach to progression within the individual specialization.

### Foundation In Biological And Physical Sciences

Because Environmental Science is an interdisciplinary field, students designing such concentrations should have a broad knowledge of the scientific disciplines that form the main foundation for work in the field. Introductory knowledge of biology, chemistry and physics will provide students with the solid foundation they need to develop a concentration in Environmental Science and to succeed in the advanced-level course work they will need to include in their degree plan. Foundational knowledge and experiences must include coverage of the core methodologies and theories of the discipline, as well as participation in experiential learning provided in laboratory and/or field activities.

- **Biology:** Students should develop an understanding of biological concepts and sub-disciplines, which typically are covered in college-level introductory biology studies. Knowledge areas should include cellular and molecular biology, microbial, plant and animal biology, as well as introductions to population and community ecology.
- **Chemistry:** Students should develop an understanding of the basic principles of chemistry and acquire the ability to perform relevant calculations, which are typically covered in introductory chemistry studies. Essential areas of knowledge include chemical bonding, molecular structure, periodic properties, thermochemistry and gases along with kinetics, equilibrium, ionic and redox equations, acid-base theory, electrochemistry, thermodynamics and gases.
- **Physics:** Students should develop an understanding of the concepts related to the major topic areas typically covered in introductory physics studies. Essential areas of knowledge include mechanics, electromagnetism, waves and optics, thermodynamics and atomic and nuclear physics.

### Environmental Science Core

Students are expected to develop a degree plan that encompasses the breadth of the field of environmental science and reflects progression within their area of interest. Students will build upon their foundational knowledge and experiences in the biological and physical sciences, moving to intermediate-level study in the natural environmental sciences, which provides breadth within the concentration and prepares students for in-depth advanced level study. At the advanced level, students may choose to select a particular path, one which best suits their academic interests and goals.

- **Biological Environmental Science:** Students should understand the dynamics of natural environmental systems, focusing on how species interact with each other and their physical environment. Essential knowledge areas include species, populations, communities and ecosystems. Examples of study titles that are commonly used to meet this expectation include Environmental Science and Ecology.
- **Physical Environmental Science:** Students should understand the dynamics of natural environmental systems, focusing on the processes shaping the physical environment. It is expected that this understanding would include both small-scale processes, such as the rock cycle, and large-scale processes, such as tectonics. Essential knowledge areas include rock formation, soil formation, nutrient cycling, water cycling, atmosphere dynamics and geologic history. Examples of study titles that are commonly used to meet this expectation include Geology and Earth Science.
- **In-Depth Knowledge and Skills:** Within their concentration, students must include advanced-level environmental science studies and experiences which provide them with the opportunity to acquire and develop:
  - Problem-solving and research skills, including definition, information gathering, analysis, research design, evaluation and testing, as well as knowledge of appropriate experimental and applications methodologies.
  - An increasingly critical and sophisticated understanding of the theoretical and conceptual models of the field.
  - An understanding of the field as an ever-evolving area of scientific knowledge and the skills required to maintain currency in environmental science.
  - A practical and a conceptual understanding of the scientific method.

Each student brings his or her own goals and background to the study of environmental science. In order to address their goals, it is common for students to focus their advanced-level study on a thematic area. For example, students interested in ecology within environmental science might include the study of ecology, conservation and biodiversity. Students interested in soil science within environmental science might include the study of soil science, agroecology, watershed management and environmental change. Students interested in meteorology and climate within environmental science might include the study of meteorology, global climate and natural disasters. Students are not limited to these examples, nor are they required to have a thematic area within their concentration. A thematic area is only one way to acquire the knowledge, skills and competencies expected of students in Environmental Science.

### Essential Skills And Larger Context

Students should complement their science foundation with their development of skills that enhance their ability to critically analyze and interpret environmental processes and phenomena and provide them

with a greater awareness of the nature of the interactions between human activities and the surrounding environment.

- **Quantitative Reasoning:** Essential to the study of environmental processes and ecosystem dynamics is the ability to quantitatively analyze data collected during laboratory and field observations and experimentation. At a minimum, students should include a statistics study or equivalent in their degree plan. Students should consider additional quantitative studies such as calculus or advanced quantitative methods as appropriate to their educational and career goals.
- **Technology:** Proficiency in the use of tools employed by environmental scientists is vital. Students should demonstrate a familiarity with current technology centered on spatial analysis including geographic positioning systems (GPS) and geographic information systems (GIS). Due to the increasing role technology is playing in the analysis and distribution of scientific data, students should demonstrate a proficiency in the technology appropriate to their focus within Environmental Science. Students also should demonstrate the ability to use technology to acquire data in field and laboratory research projects. They also should be able to use technology to analyze and interpret data with a goal of strengthening their understanding of a particular research question and identifying future areas of research. Students might demonstrate this learning through a variety of studies and/or experiences.
- **Wider Social Context:** All science is conducted within a wider social context. Thus, students should include in their concentrations studies and experiences that develop their understanding of the relationships among society, the natural world and the work of scientists. The knowledge areas and experiences that students select to complement the science components of their concentration will vary, but they should be appropriate to their future academic and career goals. Exploration of Environmental Science within the wider context might be performed within a variety of fields, such as policy, law, ethics, education, economics, literature, or communication.
- **Practicum:** Students developing concentrations in Environmental Science must include a learning experience that will provide them with practical experience in the field. Examples of ways this practical experience could be acquired include an internship, a study designed in consultation with a mentor and the assessment of prior learning experiences. Practical study provides students with the opportunity to engage in current and innovative technological methods used for experiments and the collection of data. Topic areas for practical experience include environmental research and monitoring, conservation and restoration, environmental education and environmental policy design and implementation. For example, a student interested in agricultural sustainability may intern at a local community organic farm. Students can work with their mentor to identify appropriate practical experiences.

### Capstone Experience

Students designing concentrations in Environmental Science should include a capstone study or final integrating experience in their degree plan. Within the capstone experience, students practice and reinforce the skills learned and the knowledge gained during the foundational components of their program. As a capstone experience, students might work with a mentor to design their own research projects, or they might decide to participate in a formalized research project offered through a local college or organization. The practical experience guideline may be met through the fulfillment of the capstone.

### Rationale

Students should explicitly discuss in their rationale essay how each of the above topics is incorporated in their degree program, how the program is designed to meet their goals and how the program meets the currency criteria discussed above. It is not necessary that the specific terms used above appear in individual study titles.

Effective July 1, 2013

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## Information Systems Concentration - For Students Matriculated On Or After Sept. 1, 2015

### Statements About Information Systems

Information systems (IS) specialists focus on integrating information technology solutions and business processes to meet the information needs of businesses and other enterprises, enabling them to achieve their objectives in an effective, efficient way. This discipline's perspective on information technology emphasizes information and views technology as an instrument for generating, processing and distributing information. Professionals in the discipline are primarily concerned with the information that computer systems can provide an enterprise to aid in defining and achieving its goals and the processes that an enterprise can implement or improve using information technology. Students of IS must understand both technical and organizational factors and they must be able to help an organization determine how information and technology-enabled business processes can provide a competitive advantage.

"The information systems specialist plays a key role in determining the requirements for an organization's information systems and is active in their specification, design, and implementation. As a result, such professionals require a sound understanding of organizational principles and practices so that they can serve as an effective bridge between the technical and management communities within an organization, enabling them to work in harmony to ensure that the organization has the information and the systems it needs to support its operations. Information systems professionals are also involved in designing technology-based organizational communication and collaboration systems." (Computing Curricula 2005, p. 14).

Our guiding authority for this document is Computing Curricula 2005 and the IS 2010 Body of Knowledge. This joint effort by the Association for Computing Machinery (ACM), the Association for Information Systems (AIS) and The Computer Society (IEEE-CS) includes current curricular recommendations from the leading professional organizations in the computing fields. Students should read Computing Curricula 2005 to understand how computing disciplines are related. It is important for students to think carefully about their primary interest. Information systems, as a disciplinary concentration, probably would not be the best choice for someone primarily interested in computing infrastructure needs of the organization; for such individuals, a concentration in information technology would be more appropriate. On the other hand, students interested primarily in the abstract, theoretical concepts of computing would be better served by a concentration in computer science.

There are, of course, many ways to approach information systems. Many professionals and educators have tried to identify different approaches by adding adjectives, which has led to terms such as "management information systems" (MIS) and "computer information systems" (CIS). The general understanding was that MIS would be more focused on the management aspects, while CIS focused on the technical aspects.

However, as the area has developed, the differentiation between the managerial and the technical has certainly blurred. These guidelines have, therefore, adopted the more general title of “Information Systems,” but they apply to both of those titles as well. Similarly, titles such as “Information Systems Management” also cover the same content.

At Empire State University, the variation among degrees in information systems occurs with the identification of the area of study. Each student must design a degree program that meets the general guidelines for an area of study. The information systems curricular guidelines represent a common core of knowledge, which any information systems degree will contain within those general guidelines. Students who are interested in information systems within the business and managerial perspective might find it appropriate to place their concentration within the Business Management and Economics area of study, while students who are interested in the technological perspective might find it appropriate to place their concentration within the Science, Mathematics and Technology area of study (or, if they are seeking the narrower BPS, this would be done as a concentration within the Technology registered program). All students should make sure that the degree they are interested in is appropriate for their future career and education goals.

### Foundation

**Communication:** All students should already have (or develop) skill and confidence with communication, particularly communicating in writing. Technical communication, that is the specialty of communicating technical information, is of particular value to individuals in this field.

**Quantitative reasoning:** Students must develop their quantitative reasoning and mathematical skills. At the most basic level, students should have facility with statistics to support in-depth analysis of data. Typically, in order to be prepared for a course in statistics, students should have facility with algebra.

The choice of mathematical subject matter for development of quantitative reasoning will depend on the student’s background and interest. It should be recognized that, as a part of these studies and any other work in mathematics, students should develop skill and confidence with the interpretation of material containing quantitative information and mathematical symbols, and they should have (or develop) an ability to express ideas using mathematical symbols and language. That is, it is important to be able to articulate an understanding of mathematics, not just to be able to do calculations.

**SMT students** must develop their quantitative reasoning and mathematical skill in areas such as discrete mathematics. Discrete mathematics supports algorithmic thinking and such study would cover logic, the concept of complexity, introduction to methods of proof and graph theory. Typically, students need facility in the knowledge gained from pre-calculus to have a strong experience in discrete mathematics.

**BME students** would benefit from a study in advanced quantitative methods for management, which includes topics such as decision making under uncertainty and linear programming and applications of regression analysis in management.

### Information Technology

Foundational learning in IT: **SMT students** should already have (or develop) an understanding of programming, not just coding. This involves using problem solving with logic. **BME students** should have an understanding of the fundamentals of computing in organizations and the use of information systems in organizations.

**Databases:** Students should also demonstrate an understanding of data modeling, database programming and basic database administration concepts at the enterprise-scale.

**IT infrastructure:** Students should be familiar with the technical foundations of information systems. This typically includes knowledge in operating systems and networks. Students are expected to be able to explain the capabilities and limitations of different networking devices. Students have a clear understanding of different types of networks and network protocols, layers, standards and topologies. Students are able to explain the benefits of small office/home office (SOHO) networks and the technology requirements essential to install, configure and maintain them. Students should be prepared to keep up with new developments in the networking field. For **BME students**, their understanding of IT infrastructure should include the technologies of e-commerce.

**Security:** Students are able to describe different types of security risks and threats against networks and information assets and have basic knowledge in designing secure systems and detecting and mitigating threats to the systems.

### Professional Behavior And Responsibilities

**Professional, legal and ethical responsibilities:** Students must understand their ethical, social and professional responsibilities as information systems professionals. This would typically include analysis of professional roles and responsibilities, exploration of major categories of issues, and identification of ethical issues and value conflicts, analysis and evaluation of claims using ethical frameworks. For **SMT students**, this also should include analysis of the context for the technological system, including recognizing the organizational and legal context and identifying the stakeholders.

**Organizational understanding and professional behavior:** Students should develop an understanding of how individuals and groups function or behave in organizations. It is expected that students will develop, either through direct study or as a part of other activities, their skills in leadership, collaboration and negotiation.

### Theory, Development, And Management Of Systems

**Systems analysis and design:** Students must include systems analysis and design as central to understanding information systems. This knowledge should encompass an understanding of the systems lifecycle along with issues in requirements definition and system implementation. This knowledge should be at the advanced level. The student should know the system analysis and design lifecycle from analyzing the business case through requirements modeling and system architecture to system operations and support and the major activities in each phase, as well as understand how the process helps address the larger organizational needs.

**Project management:** Students must also have skills in and knowledge of project management methodologies and skill in applying the techniques of project management. This would include the project lifecycle from planning to closing, and the key knowledge areas such as scope, cost and time management to ensure that organizational resources are planned and deployed effectively and that evaluation and quality are maintained in the system development process.

**Information Systems in the Broader Context:** Students are expected to apply the concepts of IT strategy to evaluate the organization’s use of IT in the context of its overall strategy, analyze the relationships between business and IT and apply these concepts to real-world situation.

**Individual Context**

Each student brings his or her own goals and background to the study of IS. It is these goals for future study or work which will provide the context for the student's degree. Students should address their choice in the rationale.

**Students in SMT** should develop an appreciation for the type(s) of organization in which they work, or intend to work, as well as the interpersonal and communication skills needed to be successful in that environment. For example, a student who intends to work in government (federal, state, local) should understand bureaucracies, politics and regulations, while a student who works in a scientific research environment should understand how scientists view data, design studies, etc., and a student who works in a health care setting should include informatics as well as policy issues.

**Students in BME** are expected to understand the business context within which they will be working. As such, they need a background of at least two of the functional areas, such as accounting, finance, marketing, human resources and operations management. Since this expectation is very dependent on the student's individual goals, it is vital that students, in consultation with their mentor, identify their learning needs and explain their reasoning in their rationale.

**Currency**

Information systems and the environment in which they exist are always changing. Degree programs must demonstrate currency in the field and show understanding of emerging and evolving technology and environment relevant to their individual context.

Currency can be viewed in two ways: on the one hand, currency refers to current technologies; on the other hand, currency can be seen as not-obsolete. If students want to use earlier learning in their programs, they should consider several issues related to how old, how specialized and how extensive the earlier learning is. Courses which encompassed analysis, problem definition, algorithms, data structures, programming concepts and testing methodology may provide a useful foundation to explore recent developments in computer technology. Courses which are product-specific (hardware or software) may be less useful. When earlier learning is judged to provide a useful foundation within the program, students should be sure to incorporate opportunities to bridge to newer platforms or applications within their degree program.

**Rationale**

Students should explicitly discuss in their rationale essay how each of the above topics is incorporated in their degree program, how the program is designed to meet their goals and how the program meets the currency criteria discussed above. It is not necessary that the specific terms used above appear in individual study titles.

**Additional Studies**

Students who wish to enhance their knowledge and skills might consider incorporating additional areas into their studies including human-computer interaction, which would include concepts and approaches, such as user differences, user experience and collaboration, human factors, ergonomics, accessibility issues and standards, user and task analysis and the ability to implement user-centered design and evaluation methods.

**Information Technology Concentration - For Students Matriculated On Or After July 1, 2011****About Information Technology**

IT programs exist to produce graduates who possess the right combination of knowledge and practical, hands-on expertise to take care of both an organization's information technology infrastructure and the people who use it. IT specialists assume responsibility for selecting hardware and software products appropriate for an organization, integrating those products with organizational needs and infrastructure, and installing, customizing, and maintaining those applications for the organization's computer users. Examples of these responsibilities include the installation of networks; network administration and security; the design of web pages; the development of multimedia resources; the installation of communication components; the oversight of email systems; and the planning and management of the technology lifecycle by which an organization's technology is maintained, upgraded, and replaced (Computing Curricula 2005, p. 14-15).

An information technology concentration will include organizational and social context, along with technical content and theory. This is a field in which there are external expectations; our guiding authorities for this document are Information Technology 2008 and Computing Curricula 2005. These joint efforts by The Association for Computing Machinery (ACM), The Association for Information Systems (AIS), and The IEEE Computer Society (IEEE-CS) include the latest updates of curricular recommendations from the leading professional organizations in the computing fields.

Students should read Computing Curricula 2005 to understand how the various computing disciplines are related. Information technology, as a concentration, probably would not be the optimal choice for someone primarily interested in information and the use of information technology as an instrument for generating, processing and distributing information. For such individuals, a concentration in information systems would be more appropriate. On the other hand, students who are interested primarily in the abstract, theoretical concepts of computing would be better served by a concentration in computer science.

**General Foundation**

To be successful in the workplace, students must understand the role(s) of IT in organizations as well as develop good communication and interpersonal skills. In addition, quantitative skills are foundational for study in IT.

**Communication Skills**

All students already should have (or develop) skill and confidence with communication, particularly communicating in writing.

Technical communication, that is the specialty of communicating technical information, is of particular value to individuals in this field.

**Quantitative Reasoning And Analytic Skills**

All students already should have (or develop) skill and confidence with the interpretation of material containing quantitative information and mathematical symbols, and they should have (or develop) an ability to express ideas using mathematical symbols and language. That is, it is important to be able to articulate one's understanding of mathematics, not just be able to do calculations. The choice of mathematical subject matter for development of quantitative reasoning will depend on the student's background and interest. Facility with algebra (or technical math) is a necessary foundation. In addition, students should have an understanding of

basic statistical concepts and discrete mathematics. Through these studies and others, all students already should have (or develop) skill and confidence with an analytic approach to problem solving.

### Programming

All students already should have (or develop) an understanding of programming, not just coding. This involves using problem solving with logic.

### Breadth In Information Technology

Students should show, through their degree program and their rationale, that they have both foundational knowledge and knowledge beyond the foundation in this area. Typically, at least some content in the information technology area will be at the advanced level.

### Networking

Students should demonstrate an understanding of networking (data communications and computer network models).

### Platform Technologies

Students should demonstrate an understanding of platform technologies (operating systems and computer architecture).

### Database

Students should have a familiarity with database systems and database administration concepts.

### Organizational And Social Context Professional, Legal, And Ethical Context

Students must understand their social and professional responsibilities as computer professionals as well as the role(s) of IT in the organization. This might include a combination of social context of computing, professional and ethical responsibility, methods and tools of analysis of issues, risks and liabilities of computer-based systems, information security, intellectual property, privacy and civil liberties and history of computing.

### Theory, Development And Management Of Systems

Students must include theory, development, and the management of systems in their degree plans. This includes analysis and design, human computer interaction, information assurance, web systems and project management.

### Analysis And Design

Students should recognize analysis and design as central to understanding information technology. This knowledge must encompass an understanding of the system development lifecycle with particular emphasis on issues in requirements definition and system implementation. For a student focusing on information technology, the emphasis should be on analysis of technical requirements; it is not necessary to place much emphasis on software design. This knowledge should be at the advanced level. The student should know the system analysis and design lifecycle from analyzing the business case through requirements modeling and system architecture to system operations and support and the major activities in each phase, as well as understand how the process helps address the larger organizational needs.

### Human Computer Interaction

Students must have a competence in user-centered methodologies and an understanding of how these fit within organizational contexts such as they would develop in a study of human computer interaction. Topics generally include human factors, ergonomics, accessibility issues and standards and user and task analysis.

### Information Assurance

Students must have an understanding of information assurance; a well-rounded knowledge of security and policy issues is vital in this field. Such knowledge includes information security governance, organizational needs, security risks and options for addressing these risks. Security risks include the physical, infrastructure and human threats. A focused study in network security and cryptography is insufficient.

### Project Management

Students must have skills in and knowledge of project management methodologies and skill in applying the techniques of project management. This would include the project lifecycle from planning to closing, and the key knowledge areas such as scope, cost and time management to insure that organizational resources are planned and deployed effectively.

### Web Systems

Students are expected to have competence with design, implementation and testing of web technologies and related applications. Topics generally would include information architecture, user-centered web development, web technologies, rich media, standards and standards bodies and vulnerabilities.

### Currency

Information technologies and the environment in which they exist are always changing. Degree programs must demonstrate currency in the field and show understanding of emerging and evolving technologies and environment relevant to their individual context.

Currency can be viewed in two ways: on the one hand, currency refers to current technologies; on the other hand, currency can be seen as not-obsolete. If students want to use earlier learning in their programs they should consider several issues. These relate to how old, how specialized and how extensive the earlier learning is.

- Courses that encompassed analysis, problem definition, data structures, programming concepts, computer organization, networking models and testing methodology can provide a useful foundation to explore recent developments in computer technology.
- Courses that are product-specific (hardware or software) might be less useful.

When earlier learning is judged to provide a useful foundation within the program, students should be sure to incorporate opportunities to bridge to newer platforms or applications within their degree programs.

### Rationale

Students should explicitly discuss in their rationale essay how each of the above topics is incorporated in their degree program, how the program is designed to meet their goals and how the program meets the currency criteria discussed above. It is not necessary that the specific terms used above appear in individual study titles.

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## Mathematics Concentration - For Students Matriculated On Or After July 2012

### About Mathematics

Mathematics is a continually-evolving field characterized by quantitative, deductive and analytical reasoning. Some mathematicians see mathematics as the hidden language of the universe and appreciate mathematics for its logical system of thought and the beauty of the

unexpected connections discovered among different ideas. Many mathematical journeys have been followed because they are interesting, and only later was it recognized that these journeys could be used to explain parts of physical reality. However, other mathematicians take a more practical approach, focusing on mathematics as a tool for solving complex problems through modeling.

College-level mathematics builds upon the kinds of elementary mathematical objects, concepts, and structures with which we are all familiar, such as number systems and arithmetic operations. However, college-level mathematics primarily involves manipulating, applying and generally reasoning about more complex/sophisticated abstract mathematical structures, objects and ideas.

Mathematical fields are distinguished from nonmathematical fields that use mathematics extensively, yet in which the reasoning is primarily conducted in the language of the other field. For example, in accounting, the reasoning is primarily in terms of business concepts, rather than the concepts of mathematics.

Concentrations in mathematics include a range of approaches and titles. Students seeking to think and invent in the language of mathematics as an endeavor for its own sake would most likely be working toward a concentration simply titled "mathematics." Students interested in using mathematical reasoning in order to solve practical problems might consider building a concentration in "applied mathematics." The applied mathematics concentration may focus on business-oriented applications of mathematical reasoning, the study of science and engineering-related problems that arise in research and industry, or one of many other topics determined by the student's academic interests. Beyond these, there are other, typically interdisciplinary, specializations that have a strong emphasis on using mathematical reasoning as a tool, but which are not generally considered to be subfields of mathematics itself. Examples of these vary widely, and include such fields as actuarial science, quantitative psychology and theoretical physics.

**Note:** Empire State University cannot facilitate teacher certification directly, but can provide the mathematical content needed to prepare a student to enter a master's program leading to teacher certification. Students who are seeking to teach must consult certification requirements in the state/region in which they intend to obtain certification, and should review the Mathematical Association of America's CUPM Curriculum Guide 2004; for K-8, see the discussion on pages 38-42, and for secondary school, see the discussion beginning on page 52 and the recommendations on pages 54-56.

**Note:** You will need Adobe Acrobat Reader to read the CUPM Curriculum Guide. If Acrobat Reader is not installed on your computer, you can download it for free from Adobe.

## Concentrations

### General Foundation For All Concentrations

Concentrations in mathematics and applied mathematics should include both theoretical and applied studies, rather than focus exclusively on only one perspective in the field. Likewise, concentrations in mathematics and applied mathematics should include studies in both the continuous and the discrete, although a weighted preference may be given to one branch or the other. Similarly, concentrations in mathematics and applied mathematics should include studies in both the stochastic and deterministic, as well as in both the algebraic and the geometric.

There is a common core of foundational knowledge areas that concentrations in mathematics and applied mathematics are expected to include.

- **Calculus:** Calculus, often described as the study of continuous motion or change, forms the computational basis for classical (Newtonian) physics, and is an essential foundation for further studies in all areas of mathematics that concern continuous variables. The study of calculus is built upon the notion of a limit, which is a precise mathematical construction used to describe closeness among "infinitesimal" quantities. Calculus topics are typically studied in a sequence of either three or four terms, depending on curricular design. To address the calculus expectation, students are expected to learn differential calculus, integral calculus, multivariate calculus and vector analysis.
- **Linear Algebra:** Linear algebra is the detailed study of linear systems of equations and their properties, and forms an essential foundation to further studies in mathematics. The concepts introduced in linear algebra appear in virtually every area of advanced-level undergraduate mathematics, including the continuous and the discrete, the theoretical and the applied. Linear algebra is also known by such titles as "matrix algebra," "matrix theory" and "finite dimensional vector spaces."
- **Proofs:** Logic and the construction of proofs are essential for success in any advanced-level undergraduate study in mathematics. These core skills are best developed in a study dedicated to formal logic and the construction of proofs that can serve as a transition to advanced-level studies.
- **Tools:** Proficiency in the use of tools employed by mathematical professionals is vital. Students are expected to employ such tools in problem solving, analysis and the communication and understanding of mathematical ideas; students should be exposed to these tools throughout their concentration studies. Tools might include, but are not limited to, computer algebra systems (such as Maple, Mathematica, or MATLAB), statistical packages and an algorithmic programming language. Students should select those tools that are relevant to their academic interests.

### Core For Concentration In Mathematics

In addition to the foundational knowledge described above in the General Foundation section, concentrations in mathematics should include advanced-level, proof-based studies in the core areas described below. At least one study in each of these areas is essential. A second term of study in each of these areas is recommended, and is critical for students interested in attending graduate school in mathematics.

- **Analysis:** Students in mathematics are expected to learn the theoretical underpinnings of calculus. To address this expectation, students are expected to develop the ability to understand and to create proofs about the theory of calculus, to revisit familiar concepts in the context of mathematical proof, and to analyze mathematical details and their theoretical implications. Studies that usually contain the content that would meet this expectation include real analysis, applied analysis, advanced calculus, real variables and theory of calculus.
- **Abstract Algebra:** Students in mathematics are expected to learn the theory of algebraic structures in which the sets and operations in question do not exclusively consist of the familiar numbers and arithmetic operations. To address this expectation, students are expected to develop the ability to understand and create proofs about the abstract algebraic structures known as groups, rings and fields. Studies that would usually contain content that would meet this

expectation include abstract algebra, modern algebra, introduction to group theory and Galois theory.

Students are expected to build on the core in a variety of ways, depending upon their academic interests and goals. Indeed, beyond the traditional areas mentioned above, interested students also may build on the core mathematics knowledge areas to create an individualized (possibly interdisciplinary) degree program that explores connections of mathematics to other areas of their interest, such as art, music, history or philosophy.

### Core for Concentration In Applied Mathematics

In addition to the foundational knowledge described in the General Foundation section, concentrations in applied mathematics should include the following.

- **Modeling:** Students in applied mathematics are expected to learn how to formulate and analyze mathematical models. To address this expectation, students will develop the ability to investigate not only simple models, but also to analyze more complicated models. The analysis of complex models typically requires the use of technology tools.
- **Statistics:** Students in applied mathematics are expected to develop proficiency with the use of statistics and probability on data sets. This includes the identification of appropriate tools, the application of these tools and the analysis of the results. The theoretical underpinnings of probability and statistics are usually explored within this study of statistics. Studies that usually contain the content that would meet this expectation include: mathematical statistics, probability and statistics and theory of statistics.
- **Numerical Methods:** Students in applied mathematics are expected to learn classical mathematical approaches to solving real-world, large-scale problems for which it is not possible to obtain closed-form solutions using elementary functions.
- **Applied Analysis:** Students in applied mathematics are expected to learn the theoretical underpinnings of some of the mathematical methods that are commonly applied to the analysis of problems posed in the sciences. Students will develop the ability to understand and to create proofs about these methods, and to analyze mathematical details and their theoretical implications. Studies that usually contain the content that would meet this expectation include real analysis, applied analysis, advanced calculus, real variables, complex variables, partial differential equations and special functions.

### Concentrations In Other Areas

A student might be interested in specializations related to the mathematical sciences, which include, but are not limited to, statistics, actuarial science and mathematical programming. Students interested in any of these specializations should investigate traditional curricula that are aligned with their area of interest. For each specialization, a variety of studies outside of mathematics will be important. Since many of these specializations are highly interdisciplinary in nature, the interested student might consider building such a degree program in the interdisciplinary studies area of study.

### Rationale

Students should discuss explicitly in their rationale essay how each of the above topics is incorporated in their degree program and how the program is designed to meet their goals.

## Physics Concentration - For Students Matriculated On Or After Feb. 1, 1993

Physics is the study of matter and energy. Mathematical abstraction characterizes its methodology. Physics is both empirical, based upon controlled observation, and theoretical, in the effort to relate the results of such observations together using abstract conceptual frameworks.

Physics, in fact, requires a dynamic relationship between theory and experiment, between abstract principles and observations of physical behavior. Physics is an active and ongoing attempt to improve both the theories of physics and their match with observation.

Purely theoretical work invents theory, draws testable predictions from existing principles, compares existing theories and works out the meaning of newly acquired data for existing theory

Experimental work involves designing, creating and carrying out the experiments, advancing the art of making measurements at the limits of accuracy and generating the data for testing the theories of physics.

The major areas of study in physics are:

- mechanics (force and motion)
- heat
- electricity and magnetism
- optics (light) and waves
- quantum physics

A physics concentration requires:

- at the outset, strong working knowledge of algebra, trigonometry and calculus (differential and integral)
- as early as is feasible, an introductory study of physics which utilizes calculus and which covers most or all of the major areas listed above
- intermediate or advanced-level study in all of the same five major areas, as well as laboratory work covering as many of the areas as possible
- study of calculus through differential equations is essential
- additional work in mathematics such as linear algebra, partial differential equations and complex variables

Additional study in other areas of physics is also recommended, for example, acoustics and mechanical waves, computational physics, relativity, advanced experimental techniques, atomic physics, solid state physics, nuclear physics, elementary particles, lasers and quantum optics and fluid dynamics. A final, integrative contract is desirable, possibly including some kind of direct participation in ongoing research.

Students should be proficient in use of the computer for enlarging and improving understanding of physics. Possible applications of the computer to physics include collecting and analyzing data, complex calculations, exploring the nature of analytical solutions to problems, simulations and attacking classes of problems that were not solvable in the past.

## Technology Concentration - For Students Matriculated On Or After Feb. 1, 1993

The technological professions require:

- an understanding of scientific and mathematical principles
- a detailed knowledge of relevant practices and procedures whereby those principles are applied operationally

The technologist is typically a practical person who is interested in the application of theoretical principles and in the organization of people for the achievement of practical ends.

Studies in technology include study of basic sciences with emphasis on application. Depending upon the specific technology and the scientific base of that technology, concentrations in technological fields should include:

- mathematics, for technologies based on physical or engineering sciences; mathematical study should go at least through introductory calculus
- physical or biological sciences
- knowledge of computers and computer applications
- hands-on exposure to processes, methods and procedures
- economics and management principles, if appropriate