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College of Science & Technology
Academic Program Student Learning Outcomes

Program Description	Program Degree	Student Learning Outcomes
APPLIED MATHEMATICS	**BS**	1: After completing this program, students should be able to make effective use of the concepts of calculus and linear algebra and to carry out efficiently algebraic and analytic computations.
		After completing this program, students should be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability.
		After completing this program, students should be able to communicate effectively mathematical ideas using oral, written, and/or electronic media.
		After completing this program, students should be able to use technological tools that are useful in mathematical research.
		After completing this program, students should be able to approach a mathematical problem from a variety of perspectives.
		After completing this program, students should have developed mathematical independence and have experienced open-ended inquiry.
		After completing this program, students should be able to make effective use of numerical computations.
		After completing this program, students should be able to model real-life phenomena and analyze real-life data.
BIOCHEMISTRY	**BS**	Know foundational and in-depth material in the field of biochemistry. This is based on the coursework necessary to learn biochemistry.
		Students will need to be able to read the scientific literature and they will need to have some ability to write scientific articles.
		We must have students learn safety skills. This is an essential part of the education process.
		This expectation is essential for a student who plans to be a biochemist. There are many students who obtain a biochemistry degree as a step toward a health profession goal (pre-med, pre-dent, pre-pharm). It may be that these students do not need the same level of research training.
		Students need to be able to work as part of a team. We are able to assess their independent work in the foundational coursework (and lab work), but the ability to do team work in the lab is most important in our upper level labs. The outcome is essential for industrial positions.
		Students who graduate with a degree in biochemistry need to have learned certain skills that allow them to relate chemical principles to biological systems. They do not have to show mastery of the lab skills. Not all biochemists work in labs. But they will need to know the equipment and techniques (ELISA, Southern Blots, PCR, etc.) that are used in the biochemistry field. They need to have a solid chemistry background and they must have essential biochemistry exposure.
		Students who earn a biochemistry degree must have developed problem-solving skills. This is central to all science degrees. It is a component of all critical thinking centered courses.
BIOINFORMATICS	**GRAD**	Refer to Bioinformatics PSM
BIOINFORMATICS	**PHD**	This is a new program as of Fall 2018, with five newly enrolled students.
BIOINFORMATICS	**PSM**	1. Knowledge of the fundamental principles of inheritance and of evolution
		2. Knowledge of the details of genome architecture and the processes of gene expression and of the regulation of gene expression
		3. Understanding of advanced concepts used in modern genomic research and of how to represent those concepts computationally
		4. Knowledge of protein structures and the relationship between sequence and structure

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Program Description	Program Degree	Student Learning Outcomes
BIOINFORMATICS (CONT'D)	**PSM (CONT'D)**	5. Knowledge of molecular modeling and advanced concepts used in structural bioinformatics
		6. Knowledge of the developing interface between genomic and structural bioinformatics
		7. Knowledge of algorithms and software tools from computer and information science used in bioinformatics
BIOINNOVATION	**GRAD**	Refer to Bioinnovation PSM
BIOINNOVATION	**PSM**	1. Knowledge of principles of current concepts, techniques, and trends in biological and biomedical research.
		2. Understanding of translational value and applicability of different current biodiscoveries.
		3. Knowledge of principles in technology transfer and intellectual property issues.
		4. Understanding of national, state and local policies, protocols and standards expected in the field.
		5. Development of professional skills for oral and written communication of biodiscoveries to expert and lay public through traditional and new media. Analyzing and evaluating scientific communications and proposals.
		6. Development of teamwork skills, including matrix collaborations.
BIOLOGY	**BA**	1. Thoroughly understand of the principal levels of organization of living organisms
		2. Understand the biochemical and biophysical principles that underlie living organisms
		3. comprehend principles that govern interaction between and within cells, tissues and organisms
		4. understand major principals of the discipline, such as proliferation, generation of diversity, evolution by natural selection
		6. communicate using oral, written, or electronic media, and understand attribution and acknowledgement of sources
BIOLOGY	**BS**	1. Thoroughly understand of the principal levels of organization of living organisms
		2. Understand the biochemical and biophysical principles that underlie living organisms
		3. comprehend principles that govern interaction between and within cells, tissues and organisms
		4. understand major principals of the discipline, such as proliferation, generation of diversity, evolution by natural selection
		5. critically evaluate experimental data and be familiar with laboratory procedures
		6. communicate using oral, written, or electronic media, and understand attribution and acknowledgement of sources
BIOLOGY	**MA**	New Program
BIOLOGY	**MS**	1: Critically evaluate experimental data.
		2: Communicate at a professional level using oral, written, or electronic media.
		3: Design, carry out, and assess experiments independently.
BIOLOGY	**PHD**	1: Design, carry out, and assess experiments independently
		2: Communicate at a professional level using oral, written, or electronic media
		3: Critically evaluate experimental data
		4: Teach various areas of biology
BIOLOGY WITH TEACHING	**BS**	1: 1. Thoroughly understanding of the principal levels of organization of living organisms.
		2: 2. Understand the biochemical and biophysical principles that underlie living organisms.
		3: 3. Comprehend principles that govern interaction between and within cells, tissues and organisms.

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Program Description	Program Degree	Student Learning Outcomes
BIOLOGY WITH TEACHING (CONT'D)	**BS (CONT'D)**	4: 4. Understand major principals of the discipline, including proliferation, generation of diversity, and evolution by natural selection.
		5: 5. Students can design experiments, are familiar with laboratory procedures, use probes and computers to gather and analyze data, to answer scientific questions, reduce systematic and random errors, and use statistics to interpret the results and deal with sampling errors.
		7: 7. Students apply safe laboratory procedures.
		8: 8. Students can find, read, review, acknowledge, and report on articles in the scientific literature.
		9: 9. Students can create mathematical models of scientific phenomena.
		By the end of the semester, each student will have developed and implemented 4 STEM lessons in local k-8 classroom (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions) with the assistance of a mentor teacher and the course instructor. Completion of these courses demonstrate the student's procedural proficiency in developing and implementing 5E lessons for grades k-12 aged students.
		By the end of the semester, each TUteach major will have developed and implemented a full-time semester of discipline specific lessons in a local 7-12 classroom with the assistance of a mentor teacher and the course instructor. Completion of this course will demonstrate the students independent proficiency in developing a full semester of curriculum for grades 7-12 aged students and consequently enables the student to graduate.
BIOLOGY/NEUROSCIENCE	**PHD**	See Biology Ph.D.
BIOPHYSICS	**BS**	1: understand fundamental principles of physics and their ability to apply these principles for understanding how biological systems work
		2: understand fundamental principles of chemistry and their ability to apply these principles for understanding how biological systems work
		3: understand fundamental principles of molecular biology and their ability to apply these principles for understanding how biological systems work
		4: use mathematical methods to study physical models methods include single and multivariate calculus, coordinate systems (vector algebra and vector differential operators, Fourier series, ordinary and partial differential equations, boundary value problems, matrices and determinants, and functions of complex variables
		5: have written communication skills that enable students to explain their work to other people in the field.
BIOTECHNOLOGY	**GRAD**	Refer to Biotechnology PSM
BIOTECHNOLOGY	**PSM**	1: Knowledge of fundamental principles used to address as well as state of the art methods and technologies to solve problems in biotechnology
		2: An understanding of ethical standards of integrity, honesty and fairness within the profession
		3: Professional communication skills for oral and written presentations
		5: Proficiency in collecting, analyzing, documenting and validating data
		7: Leadership abilities to contribute effectively within the profession (e.g., lead lab teams, make development and planning decisions, lead in management and marketing decisions)
		8: Develop teamwork skills
CHEMISTRY	**BA**	1: Know material from foundational and in-depth course work in 4 out of 5 subdivisions of chemistry: Analytical Chemistry, Biochemistry, Inorganic Chemistry, Organic Chemistry, Physical Chemistry
		2: Have laboratory skills in a broad range of subdivisions through laboratory experience in 4 of 5 chemistry subdivisions

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CHEMISTRY (CONT'D)	**BA (CONT'D)**	3: Have problem-solving skills such as the ability to use data analysis in order to make logical conclusions concerning chemical reactivity and/or properties.
		4: Students will be able to access chemical literature using library resources and online platforms.
		5: Have laboratory safety skills
CHEMISTRY	**BS**	1: Know material from foundational and in-depth course work in the following subdivisions of chemistry: Analytical Chemistry; Inorganic Chemistry; Organic Chemistry; Physical Chemistry.
		2: Have laboratory skills in a broad range of subdivisions through laboratory experience in the chemistry subdivisions (organic, physical, and analytical are required).
		3: Have problem-solving skills such as the ability to: (i) think critically in classroom, (ii) design and execute experiments, (iii) carry out data analysis, and (iv) develop testable hypotheses for those who work in the research lab.
		4: Students take writing intensive courses. Students use the literature in advanced undergraduate courses and undergraduate research.
		5: Have laboratory safety skills
		6: Be able to communicate knowledge of chemistry using a project developed in the capstone course (Chem 4196)
		7: Be able to work effectively as part of a team as expected in various laboratory and lecture courses
CHEMISTRY	**MA**	1: Know the basic principles of his/her chosen subdiscipline (i.e. Organic, Physical, Biochemical, Inorganic and Analytical Chemistry)
		2: Demonstrate the ability to conduct independent research in that area
		3: Have the ability to communicate the results of their research through the preparation of articles for publication in one of the many peer-reviewed journals devoted to their subdiscipline
CHEMISTRY	**MS**	1: Know the basic principles of his/her chosen subdiscipline (i.e. Organic, Physical, Biochemical, Inorganic and Analytical Chemistry)
		2: Demonstrate the ability to conduct independent research in that area
		3: Have the ability to communicate the results of their research through the preparation of articles for publication in one of the many peer-reviewed journals devoted to their subdiscipline
CHEMISTRY	**PHD**	1: Know the basic principles of his/her chosen subdiscipline (i.e. Organic, Physical, Biochemical, Inorganic and Analytical Chemistry)
		2: Demonstrate the ability to conduct independent research in that area
		3: Have the ability to communicate the results of their research orally and through the preparation of articles for publication in one of the many peer-reviewed journals devoted to their subdiscipline
CHEMISTRY WITH TEACHING	**BS**	By the end of the semester, each student will have developed and implemented 4 STEM lessons in local k-8 classroom (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions) with the assistance of a mentor teacher and the course instructor. Completion of these courses demonstrate the student's procedural proficiency in developing and implementing 5E lessons for grades k-12 aged students.
		By the end of the semester, each TUteach major will have developed and implemented a full-time semester of discipline specific lessons in a local 7-12 classroom with the assistance of a mentor teacher and the course instructor. Completion of this course will demonstrate the students independent proficiency in developing a full semester of curriculum for grades 7-12 aged students and consequently enables the student to graduate.

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Program Description	Program Degree	Student Learning Outcomes
COMPUTATIONAL DATA SCIENCE	**MS**	Exhibit above average mastery of advanced data structures and algorithms used in computer science.
		After completing this program, students should be able to model real-life phenomena and analyze real-life data under time constraints and involving big data.
		Exhibit familiarity with specific area of CS (e.g. cloud computing, machine learning, networking)
		Show the ability to apply theoretical and conceptual knowledge to address CS related problems.
		Be able to do independent thinking, to identify pertinent research and be able to formulate and carry out a research plan.
		Be employable in data science related fields or able to further their education in professional school programs.
COMPUTER & INFORMATION SCIENCE	**PHD**	Demonstrate the ability to conduct independent research.
		Demonstrate knowledge of the basic principles of the computer science discipline (e.g., Computer and Network Systems, Information Systems, Software Systems).
		Demonstrate the ability to communicate the results of research through preparation of articles for publication in a peer reviewed venue.
COMPUTER SCIENCE	**BA**	Students will be proficient in at least one programming language and can write, test, and debug software programs.
		Students will be able to apply existing algorithms and/or design new algorithms that are appropriate for solving a given problem.
		Students will be able to apply knowledge of hardware and operating systems in order to develop reliable and efficient systems.
		Students will be able to apply mathematical concepts to solve problems in the computing discipline.
		Students will be able to communicate effectively about concepts within the computing discipline.
COMPUTER SCIENCE	**BS**	Students will be proficient in at least one programming language and can write, test, and debug software programs
		Students will be able to apply existing algorithms and/or design new algorithms that are appropriate for solving a given problem.
		Students will be able to apply knowledge of hardware and operating systems in order to develop reliable and efficient systems.
		Students will be able to apply mathematical concepts to solve problems in the computing discipline.
		Students will be able to communicate effectively about concepts within the computing discipline.
COMPUTER SCIENCE	**GRAD**	Refer to Computer Science MS
COMPUTER SCIENCE	**MS**	Exhibit above average mastery of advanced data structures and algorithms used in computer science.
		Be proficient in operating systems concepts.
		Exhibit familiarity with specific area of CS (e.g. cloud computing, machine learning, networking)
		Show the ability to apply theoretical and conceptual knowledge to address CS related problems.
		Be able to do independent thinking, to identify pertinent research and be able to formulate and carry out a research plan
		Be employable in CS related fields or able to further their education in professional school programs.
COMPUTER SCIENCE AND PHYSICS	**BS**	Students will be proficient in at least one programming language and can write, test, and debug software programs.
		Students will be able to apply existing algorithms and/or design new algorithms that are appropriate for solving a given problem.

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Program Description	Program Degree	Student Learning Outcomes
COMPUTER SCIENCE AND PHYSICS (CONT'D)	**BS (CONT'D)**	Understand fundamental principles of physics and apply these principles to problems in classical mechanics, electromagnetism, optics and wave phenomena, thermodynamics and statistical mechanics, quantum mechanics, atomic physics, special relativity, and specialized topics.
		Students will be able to apply mathematical concepts to solve problems in both the physics and computing disciplines.
		Students will be able to communicate effectively about concepts within both the physics and computer science disciplines.
COMPUTER SECURITY AND DIGITAL FORENSICS	**CERT**	Refer to Computer Science BS
CYBER DEFENSE AND INFORMATION ASSURANCE	**PSM**	Be knowledgeable of fundamental principals of cyber security
		Be able to recognize and employ in problem solving data structures and algorithms used in computer science.
		Be employable in IT related fields or able to further their education in professional school programs.
DATA SCIENCE	**BS**	Students will be proficient in at least one programming language and can write, test, and debug software programs.
		Students will be able to apply existing algorithms and/or design new algorithms that are appropriate for solving a given problem.
		After completing this program, students should be able to model real-life phenomena and analyze real-life data under time constraints and involving big data.
		Students will be able to apply mathematical concepts to solve problems in data science..
		Students will be able to communicate effectively about concepts within the data science discipline.
DATA SCIENCE: COMPUTATIONAL ANALYSIS	**CERT**	Refer to Data Science BS
EARTH AND SPACE SCIENCE WITH TEACHING	**BS**	1: 1. Acquire a strong knowledge foundation in earth science and related sciences.
		2: 2. Be employable in earth science-related fields or able to further their education in graduate or professional school programs.
		3: 3. Students can design experiments, use probes and computers to gather and analyze data, to answer scientific questions, reduce systematic and random errors, and use statistics to interpret the results and deal with sampling errors.
		6: 6. Students can find, read, review and report on articles in the scientific literature.
		7: 7. Students can create mathematical models of scientific phenomena.
		9: 9. Students can present research results in oral and written form.
		By the end of the semester, each student will have developed and implemented 4 STEM lessons in local k-8 classroom (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions) with the assistance of a mentor teacher and the course instructor. Completion of these courses demonstrate the student's procedural proficiency in developing and implementing 5E lessons for grades k-12 aged students.
		By the end of the semester, each TUteach major will have developed and implemented a full-time semester of discipline specific lessons in a local 7-12 classroom with the assistance of a mentor teacher and the course instructor. Completion of this course will demonstrate the students independent proficiency in developing a full semester of curriculum for grades 7-12 aged students and consequently enables the student to graduate.
ENVIRONMENTAL PROFESSIONAL TRAINING	**CERT**	Refer to Geology BS and Environmental Science BS

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Program Description	Program Degree	Student Learning Outcomes
ENVIRONMENTAL SCIENCE	**BS**	1: Understand how humans impact and alter the natural environment. Be able to distinguish natural and human alteration of the environment.
		2: Develop both a disciplinary and interdisciplinary background to make decisions about environmental problems. Successfully complete both introductory and higher level coursework in multiple departments.
		3: Develop an understanding of specific environmental problems and field methods.
FORENSIC CHEMISTRY	**PSM**	Students will gain a theoretical understanding of major concepts in forensic chemistry.
		Students will gain a range of practical skills in forensic chemistry.
FUNDAMENTALS OF PROGRAMMING	**CERT**	Refer to Information Science & Technology BS
GENERAL SCIENCE WITH TEACHING	**BS**	By the end of the semester, each student will have developed and implemented 4 STEM lessons in local k-8 classroom (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions) with the assistance of a mentor teacher and the course instructor. Completion of these courses demonstrate the student's procedural proficiency in developing and implementing 5E lessons for grades k-12 aged students.
		By the end of the semester, each TUteach major will have developed and implemented a full-time semester of discipline specific lessons in a local 7-12 classroom with the assistance of a mentor teacher and the course instructor. Completion of this course will demonstrate the students independent proficiency in developing a full semester of curriculum for grades 7-12 aged students and consequently enables the student to graduate.
		By the end of the degree, each General Science with Teaching major will complete and pass 124 total credits, where they satisfy university and college requirements and 81-89 major courses outlined on the major sheet. This includes at least 9 courses required for the major, 6 courses in CST and 3 courses in Education must be completed at Temple. In addition, 2 of the 4 concentration area courses must be completed at Temple. Though not required, students are strongly encouraged to increase training and field work experience by enrolling in SCTC 1385, SCTC 2385, or SCTC 2389. Students will also benefit from directed laboratory projects offered through SCTC 3185.. This will demonstrate a strong balance of knowledge across all general science disciplines.
GENOME MEDICINE	**CERT**	Refer to Biology BS
GEOLOGY	**BA**	1: Acquire a strong knowledge foundation in geology and related sciences
		2: Understand how to research the literature and formulate geologic hypotheses
		3: Apply theoretical, conceptual, and observational knowledge to the analysis of geologic data, and solve geologic problems
		5: Demonstrate competence in scientific inquiry, writing, and oral presentation
GEOLOGY	**BS**	1: Acquire a strong knowledge foundation in geology and related sciences
		2: Understand how to research the literature and formulate geologic hypotheses
		3: Apply theoretical, conceptual, and observational knowledge to the analysis of geologic data, and solve geologic problems
		5: Demonstrate competence in scientific inquiry, writing, and oral presentation

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GEOLOGY	**MS**	Demonstrate functional proficiency in a broad range of geologic concepts. Geology is a very interdisciplinary science. We incorporate aspects of every science into our research, including biology, chemistry, computer science, mathematics, and physics. This blending of scientific disciplines gives rise to some of our common geological specialties, such as geochemistry, geophysics, paleontology, and planetary geology. As such, we require our students to have a basic understanding of fundamental geological concepts which crosscut our entire discipline.
		Acquire a strong knowledge foundation in the studentâ€™s particular area of research. A consequence of any MS program in geology is that the student must narrow down their range of interests and focus on one particular research topic/problem during their time with us. In order to achieve this focus and develop their foundational knowledge, we tailor a selection of graduate-level classes that can be applied to the student's particular area of research. Foundational knowledge is deepened by direct mentorship by a research advisor and two additional faculty who provide incremental feedback on research and guide students to key resources and through skill development.
		Since our MS program requires the submission of an independent and original body of research for their thesis, graduate students must understand how to research the literature and formulate hypotheses for preparation of their thesis proposal.
		Be able to apply theoretical, conceptual, and observational knowledge to the analysis of geologic data, testing of hypotheses, and solution of geologic problems related to thesis research.
		Demonstrate competence in scientific inquiry, writing, and oral presentation of research.
		Be employable in earth science-related fields or able to further their education in Ph.D. or professional school programs.
GEOSCIENCE	**PHD**	Acquire a strong knowledge foundation in the studentâ€™s particular area of research. In order to achieve this focus and develop their foundational knowledge, we tailor a selection of graduate-level classes that can be applied to the student's particular area of research. Foundational knowledge is deepened by direct mentorship by a research advisor and two additional faculty who provide incremental feedback on research and guide students to key resources and through skill development.
		Successful PhD graduates are able to identify the cutting edge of research in their chosen field, and anticipate the needs of industry, society, and the environment.
		Prepare a research proposal for innovative research.
		Be able to apply theoretical, conceptual, and observational knowledge to the analysis of geologic data, testing of hypotheses, and solution of geologic problems related to thesis research.
		Demonstrate competence in scientific inquiry, writing, and oral presentation of research.
		Be employable in Earth science-related fields.
HIGH-PERFORMANCE COMPUTING FOR SCIENTIFIC APPLICATIONS	**PSM**	New Program
INFORMATION SCIENCE & TECHNOLOGY	**BA**	Students will be proficient in at least one programming language and can write, test, and debug software programs.
		Students will be able to apply existing algorithms and/or design new algorithms that are appropriate for solving a given problem.
		Students will be able to apply knowledge of hardware and operating systems in order to develop reliable and efficient systems.
		Students will be able to apply mathematical concepts to solve problems in the computing discipline.

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Program Description	Program Degree	Student Learning Outcomes
INFORMATION SCIENCE & TECHNOLOGY (CONT'D)	**BA (CONT'D)**	Students will be able to communicate effectively about concepts within the computing discipline.
		Students will be able to effectively work as part of a team to design software systems
INFORMATION SCIENCE & TECHNOLOGY	**BS**	Students will be proficient in at least one programming language and can write, test, and debug software programs.
		Students will be able to apply existing algorithms and/or design new algorithms that are appropriate for solving a given problem.
		Students will be able to apply knowledge of hardware and operating systems in order to develop reliable and efficient systems.
		Students will be able to apply mathematical concepts to solve problems in the computing discipline.
		Students will be able to communicate effectively about concepts within the computing discipline.
		Students will be able to effectively work as part of a team to design software systems
INFORMATION SCIENCE & TECHNOLOGY	**MS**	1: Possess in-depth, technical understanding of business process management
		2: Possess in-depth, technical understanding of the processes of software development and its management
		3: Possess in-depth, technical understanding of systems security / privacy and software systems administration
		4: Possess in-depth, technical understanding of emerging technologies
		5: Possess in-depth, technical understanding of networks, databases, and/or Web technologies
INFORMATION SCIENCE AND TECHNOLOGY	**GRAD**	Refer to Information Science & Technology MS
MATHEMATICAL ECONOMICS	**BA**	After completing this program, students should be able to make effective use of the concepts of calculus and linear algebra and to carry out efficiently algebraic and analytic computations.
		After completing this program, students should be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability.
		After completing this program, students should be able to communicate effectively mathematical ideas using oral, written, and/or electronic media.
		After completing this program, students should be able to use technological tools that are useful in mathematical research.
		After completing this program, students should be able to approach a mathematical problem from a variety of perspectives.
		After completing this program, students should have developed mathematical independence and have experienced open-ended inquiry.
MATHEMATICS	**BA**	After completing this program, students should be able to make effective use of the concepts of calculus and linear algebra and to carry out efficiently algebraic and analytic computations.
		After completing this program, students should be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability.
		After completing this program, students should be able to communicate effectively mathematical ideas using oral, written, and/or electronic media.
		After completing this program, students should be able to use technological tools that are useful in mathematical research.
		After completing this program, students should be able to approach a mathematical problem from a variety of perspectives.
		After completing this program, students should have developed mathematical independence and have experienced open-ended inquiry.

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MATHEMATICS	**BS**	After completing this program, students should be able to make effective use of the concepts of calculus and linear algebra and to carry out efficiently algebraic and analytic computations.
		After completing this program, students should be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability.
		After completing this program, students should be able to communicate effectively mathematical ideas using oral, written, and/or electronic media.
		After completing this program, students should be able to use technological tools that are useful in mathematical research.
		After completing this program, students should be able to approach a mathematical problem from a variety of perspectives.
		After completing this program, students should have developed mathematical independence and have experienced open-ended inquiry.
MATHEMATICS	**MS**	1: Communicate advanced mathematical concepts orally and in written form.
		2: Understand and construct advanced rigorous mathematical arguments.
		3: Effectively search mathematical literature and appropriately credit existing results.
		5: Apply mathematical principles in order to solve problems arising in applications (possibly including the design of numerical simulations to model natural phenomena for those in the applied fields).
		6: Successfully write and defend a Masters Thesis or pass the Qualifying Examinations at the Masters level.
		4: Effectively process and evaluate both theoretical and real-life quantitative data.
MATHEMATICS	**PHD**	1: Successfully complete the Ph.D. level examinations such as the Qualifying and Oral Exam.
		2: Communicate advanced mathematical concepts orally and in written form.
		3: Understand and construct advanced rigorous mathematical arguments
		4: Effectively search mathematical literature and appropriately credit existing results.
		5. Formulate a research problem as a mathematical conjecture and design a long-range strategy for attacking this.
		6. Conduct independent research.
		7. Successfully write and defend a Ph.D. thesis.
		8. Successfully teach at the collegiate level (designing and grading quizzes and tests, grading homework, and holding effective office hours).
		09. Apply mathematical principles in order to solve problems arising in applications (possibly including the design of numerical simulations to model natural phenomena for those in the applied fields).
MATHEMATICS AND COMPUTER SCIENCE WITH TEACHING	**BS**	By the end of the semester, each student will have developed and implemented 4 STEM lessons in local k-8 classroom (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions) with the assistance of a mentor teacher and the course instructor. Completion of these courses demonstrate the student's procedural proficiency in developing and implementing 5E lessons for grades k-12 aged students.

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Program Description	Program Degree	Student Learning Outcomes
MATHEMATICS AND COMPUTER SCIENCE WITH TEACHING (CONT'D)	**BS (CONT'D)**	By the end of the semester, each TUteach major will have developed and implemented a full-time semester of discipline specific lessons in a local 7-12 classroom with the assistance of a mentor teacher and the course instructor. Completion of this course will demonstrate the students independent proficiency in developing a full semester of curriculum for grades 7-12 aged students and consequently enables the student to graduate.
		After completing this program, students should be able to make effective use of the concepts of calculus and linear algebra and to carry out efficiently algebraic and analytic computations.
		After completing this program, students should be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability.
		After completing this program, students should be able to communicate effectively mathematical ideas using oral, written, and/or electronic media.
		After completing this program, students should be able to use technological tools that are useful in mathematical research.
		After completing this program, students should be able to approach a mathematical problem from a variety of perspectives.
		After completing this program, students should have developed mathematical independence and have experienced open-ended inquiry.
MATHEMATICS AND TECHNOLOGY WITH TEACHING	**BS**	By the end of the semester, each student will have developed and implemented 4 STEM lessons in local k-8 classroom (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions) with the assistance of a mentor teacher and the course instructor. Completion of these courses demonstrate the student's procedural proficiency in developing and implementing 5E lessons for grades k-12 aged students.
		By the end of the semester, each TUteach major will have developed and implemented a full-time semester of discipline specific lessons in a local 7-12 classroom with the assistance of a mentor teacher and the course instructor. Completion of this course will demonstrate the students independent proficiency in developing a full semester of curriculum for grades 7-12 aged students and consequently enables the student to graduate.
		After completing this program, students should be able to make effective use of the concepts of calculus and linear algebra and to carry out efficiently algebraic and analytic computations.
		After completing this program, students should be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability.
		After completing this program, students should be able to communicate effectively mathematical ideas using oral, written, and/or electronic media.
		After completing this program, students should be able to use technological tools that are useful in mathematical research.
		After completing this program, students should be able to approach a mathematical problem from a variety of perspectives.
		After completing this program, students should have developed mathematical independence and have experienced open-ended inquiry.

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College of Science & Technology
Academic Program Student Learning Outcomes

Program Description	Program Degree	Student Learning Outcomes
MATHEMATICS WITH TEACHING	**BS**	By the end of the semester, each student will have developed and implemented 4 STEM lessons in local k-8 classroom (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions) with the assistance of a mentor teacher and the course instructor. Completion of these courses demonstrate the student's procedural proficiency in developing and implementing 5E lessons for grades k-12 aged students.
		By the end of the semester, each TUteach major will have developed and implemented a full-time semester of discipline specific lessons in a local 7-12 classroom with the assistance of a mentor teacher and the course instructor. Completion of this course will demonstrate the students independent proficiency in developing a full semester of curriculum for grades 7-12 aged students and consequently enables the student to graduate.
		After completing this program, students should be able to make effective use of the concepts of calculus and linear algebra and to carry out efficiently algebraic and analytic computations.
		After completing this program, students should be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability.
		After completing this program, students should be able to communicate effectively mathematical ideas using oral, written, and/or electronic media.
		After completing this program, students should be able to use technological tools that are useful in mathematical research.
		After completing this program, students should be able to approach a mathematical problem from a variety of perspectives.
		fter completing this program, students should have developed mathematical independence and have experienced open-ended inquiry.
MATHEMATICS/COMPUTER SCIENCE	**BS**	Students will be proficient in at least one programming language and can write, test, and debug software programs.
		Students will be able to apply existing algorithms and/or design new algorithms that are appropriate for solving a given problem.
		After completing this program, students should be able to approach problems in both mathematics and computer science from a variety of perspectives.
		Students will be able to apply mathematical concepts to solve problems in both the mathematical and computing disciplines.
		Students will be able to communicate effectively about concepts within both the mathematics and computer science disciplines.
MATHEMATICS/PHYSICS	**BS**	1: fundamental principles of mathematics and their ability to apply these principles in the solution of problems in calculus, algebra and specialized topics
		2: fundamental principles of physics and their ability to apply these principles to problems in classical mechanics, electromagnetism, optics and wave phenomena, thermodynamics and statistical mechanics, quantum mechanics, atomic nuclear and particles physics, special relativity and specialized topics
		3: laboratory skills for the analysis of physical systems, including data and error analysis, electronics, instrumentation, radiation detection, counting statistics, interaction of charged particles with matter, lasers and optical interferometers, dimensional analysis, fundamental applications of probability and statistics
		4: the ability to process and evaluate effectively both theoretical and real-life quantitative data.
		5: communication using oral, written, or electronic media, and have the teamwork and leadership skills needed to recognize, isolate, and solve mathematical problems.

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NATURAL SCIENCES	**BA**	By the end of the degree, each natural science BA major will complete and pass 123 total credits, where they satisfy university and college requirements and 60-69 major courses outlined on the major sheet. This includes 2 upper-level liberal arts courses and a second level of a foreign language. This will demonstrate a strong balance of knowledge across all natural sciences and the liberal arts.
		By the end of the SCTC 4396 semester, each natural science BA major will create a research project from start to finish, including data analysis, to demonstrate an appropriate level of integrated knowledge of statistical concepts and skill with regards to research methods.
		By the end of the degree, each natural science BA major will complete and pass a comprehensive exam which will demonstrate the students comprehension as a whole, across all of the natural science fields.
		By the end of the SCTC 4396 semester, each natural science BA major will create a research project from start to finish, including data analysis, to demonstrate an appropriate level of integrated knowledge of statistical concepts and skill with regards to research methods.
NATURAL SCIENCES	**BS**	By the end of the degree, each natural science BS major will complete and pass a comprehensive exam which will demonstrate the students comprehension as a whole, across all of the natural science fields.
		By the end of the degree, each natural science BS major will complete and pass 123 total credits, where they satisfy university and college requirements and 74-85 major courses outlined on the major sheet. This will demonstrate a strong foundation of knowledge across all natural sciences disciplines.
NEUROSCIENCE: CELLULAR AND MOLECULAR	**BS**	1. Thoroughly understand of the principal levels of organization of living organisms
		2. Understand the biochemical and biophysical principles that underlie living organisms
		3. comprehend principles that govern interaction between and within cells, tissues and organisms
		4. understand major principals of the discipline, such as proliferation, generation of diversity, evolution by natural selection
		5. critically evaluate experimental data and be familiar with laboratory procedures, particularly those related to Neuroscience
		6. communicate using oral, written, or electronic media, and understand attribution and acknowledgement of sources
PHARMACEUTICAL SCIENCES	**BS**	Students will have a deep understanding of how the basic sciences integrate into the field of pharmaceutical science.
PHYSICS	**BA**	1: understand fundamental principles of physics and apply these principles to problems in classical mechanics, electromagnetism, optics and wave phenomena, thermodynamics and statistical mechanics, quantum mechanics, atomic physics, special relativity, and specialized topics
		2: have appropriate laboratory skills for the analysis of physical systems. These include data and error analysis, instrumentation, radiation detection, counting statistics, and dimensional analysis
		3: use mathematical methods to study physical models. Such mathematical methods include single and multivariate calculus, coordinate systems (rectangular, cylindrical, and spherical), vector algebra and vector differential operators, Fourier series, ordinary and partial differential equations, boundary value problems, matrices and determinants, and functions of complex variables
		4: have appropriate oral and written communication skills that enable students to explain their work to people from a wide variety of backgrounds.
		5: have a basic understanding of elementary principles of other natural science such as astronomy, chemistry, biology or geology and their ability to apply these principles in the solution of problems

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Program Description	Program Degree	Student Learning Outcomes
PHYSICS	**BS**	1: understand fundamental principles of physics and apply these principles to problems in classical mechanics, electromagnetism, optics and wave phenomena, thermodynamics and statistical mechanics, quantum mechanics, atomic physics, special relativity, and specialized topics
		2: 2. have appropriate laboratory skills for the analysis of physical systems. These include data and error analysis, instrumentation, radiation detection, counting statistics, and dimensional analysis.
		3: 3. use mathematical methods to study physical models. Such mathematical methods include single and multivariate calculus, coordinate systems (rectangular, cylindrical, and spherical), vector algebra and vector differential operators, Fourier series, ordinary and partial differential equations, boundary value problems, matrices and determinants, and functions of complex variables
		4: 4. have appropriate oral and written communication skills that enable students to explain their work to people from a wide variety of backgrounds.
		5: 5. have a basic understanding of elementary principles of other natural science such as astronomy, chemistry, biology or geology and their ability to apply these principles in the solution of problems
PHYSICS	**MS**	1. Proficiency in Analytical Mechanics
		2. Proficiency in Electromagnetic Theory
		3. Proficiency in Mathematical Physics
		4. Proficiency in Numerical Methods in Physics
		5. Proficiency in Quantum Mechanics
		6. Proficiency in Thermodynamics and Statistical Physics
		7. Ability to solve Physical Problems at graduate level
		8. Ability to discuss Physical Phenomena and Physical Principles
		9. Ability to perform Independent Research
PHYSICS	**PHD**	1. Proficiency in Analytical Mechanics
		2. Proficiency in Electromagnetic Theory
		3. Proficiency in Mathematical Physics
		4. Proficiency in Numerical Methods in Physics
		5. Proficiency in Quantum Mechanics (including advanced level)
		6. Proficiency in Thermodynamics and Statistical Physics
		Basic knowledge in Solid State Physics
		8. Basic knowledge in Nuclear and Particle Physics
		9. Ability to solve Physical Problems at graduate level
		10. Ability to discuss Physical Phenomena and Physical Principles
		11. Ability to perform Independent Research at an advanced level
PHYSICS WITH TEACHING	**BS**	1: understand fundamental principles of physics and apply these principles to problems in classical mechanics, electromagnetism, optics and wave phenomena, thermodynamics and statistical mechanics, quantum mechanics, atomic physics, special relativity, and specialized topics
		2: have appropriate laboratory skills for the analysis of physical systems. These include data and error analysis, instrumentation, radiation detection, counting statistics, and dimensional analysis
		3: use mathematical methods to study physical models. Such mathematical methods include single and multivariate calculus, coordinate systems (rectangular, cylindrical, and spherical), vector algebra and vector differential operators, Fourier series, ordinary and partial differential equations, boundary value problems, matrices and determinants, and functions of complex variables
		4: have appropriate oral and written communication skills that enable students to explain their work to people from a wide variety of backgrounds

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Academic Program Student Learning Outcomes

Program Description	Program Degree	Student Learning Outcomes
PHYSICS WITH TEACHING (CONT'D)	**BS (CONT'D)**	5: have a basic understanding of elementary principles of other natural science such as astronomy, chemistry, biology or geology and their ability to apply these principles in the solution of problems
		By the end of the semester, each student will have developed and implemented 4 STEM lessons in local k-8 classroom (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions) with the assistance of a mentor teacher and the course instructor. Completion of these courses demonstrate the student's procedural proficiency in developing and implementing 5E lessons for grades k-12 aged students.
PHYSICS WITH TEACHING	**BS**	By the end of the semester, each TUteach major will have developed and implemented a full-time semester of discipline specific lessons in a local 7-12 classroom with the assistance of a mentor teacher and the course instructor. Completion of this course will demonstrate the students independent proficiency in developing a full semester of curriculum for grades 7-12 aged students and consequently enables the student to graduate.
SCIENTIFIC WRITING	**GRAD**	Refer to Scientific Writing PSM
SCIENTIFIC WRITING	**PSM**	Knowledge of a broad range of communication areas including print and broadcast news, magazines, and new technologies.
		An understanding of ethical standards of integrity, honesty and fairness within the scientific profession.
		Learn how to develop a fundable research proposal, including significance, timeframe, expertise, and available facilities.
		Learn how to use appropriate database search engines (PUBMED) to obtain background material and identify relevant funding sources (Grants.gov, NIH, NSF, SPIN, COS).
		Learn the basic parts of a research proposal including; abstract, background and significance, specific aims, experimental design, expected results, pitfalls and alternative approaches and a reasonable budget.
		Understand research methodology of clinical study design in using objectives, endpoints, dependent/independent variables, data collection, and analyses.
		Understand phases of clinical development from pre-clinical research to post-marketing surveillance. Learn key medical writing deliverables in clinical development, such as writing a clincal study report (CSR) on the methods and results of a clinical trial.
		Develop skills in both written and oral presentation in communicating science to an audience of non-scientists. Students will develop the ability to break down complex scientific discoveries into accurate yet understandable explanations.
		Leadership ability in the scientific writing profession which entails providing clear and accurate scientific documentation to government laboratories, pharmaceutical companies, non-profit organizations or scientific publishing houses.