Temple University

College of Science and 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.
		2: 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.
		3: After completing this program, students should be able to communicate effectively mathematical ideas using oral, written, and/or electronic media.
		4: After completing this program, students should be able to use technological tools that are useful in mathematical research.
		5: After completing this program, students should be able to approach a mathematical problem from a variety of perspectives.
		6: After completing this program, students should have developed mathematical independence and have experienced open-ended inquiry.
		7: After completing this program, students should be able to make effective use of numerical computations.
		8: After completing this program, students should be able to model real-life phenomena and analyze real-life data.
BIOCHEMISTRY	**BS**	Students need to know foundational and in-depth material in the field of biochemistry. This outcome is a result of the coursework necessary to learn biochemistry.
		Students need to be able to read the scientific literature in order to become professionals in science related fields such as biochemistry. Students who become biochemists 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 is obvious that these students do not need the same level of research training. Not all biochemistry majors are going to become biochemists. Those who do become biochemists need to know how to develop and explore a research problem.
		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 in the biochemistry field.
		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.

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Program Description	Program Degree	Student Learning Outcomes
BIOCHEMISTRY (CONT'D)	**BS (CONT'D)**	Students who earn a biochemistry degree must have developed problem-solving skills. This is central to all science degrees and a necessary skill set for all science-related professions. It is a component of all critical thinking centered courses.
BIOINFORMATICS	**GRAD**	SLO1 1. Knowledge of the fundamental principles of inheritance and of evolution
		SLO 2. Knowledge of genome architectureand the processes of gene expression and of the regulation of gene expression
		SLO 3. Understanding of advanced concepts used in modern genomic research and of how to represent those concepts computationally
		SLO 4. Knowledge of protein structures and the relationship between sequence and structure
		SLO 5. Knowledge of molecular modeling and advanced concepts used in structural bioinformatics
		SLO 6. Knowledge of the developing interface between genomic and structural bioinformatics
		SLO 7. Knowledge of algorithms and software tools from computer and information science used in bioinformatics
BIOINFORMATICS	**PHD**	Students will be trained to analytically solve complex problems via a bioinformatics framework.
		Students will be trained to communicate their work across various platforms.
		Students will be trained to think quantitatively about the data they analyse.
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
		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**	Knowledge of principles of current concepts, techniques, trends in biological and biomedical research.
		Understanding of translational value and applicability of different current biodiscoveries.
		Knowledge of principles in technology transfer and intellectual property issues.
		Understanding of national, state and local policies, protocols and standards expected in the field.
		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.

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Program Description	Program Degree	Student Learning Outcomes
BIOINNOVATION (CONT'D)	**GRAD (CONT'D)**	Development of teamwork skills, including matrix collaborations.
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. Understanding of national, state and local policies, protocols and standards expected in the field.
		4. 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.
		5. Development of teamwork skills, including matrix collaborations.
		6. Knowledge of principles in technology transfer and intellectual property issues.
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
		5. 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**	Advanced knowledge in one or more fields of biology
		Effective communication at a professional level using oral, written, or electronic media
		Proficiency in searching, analyzing and interpreting primary scientific literature
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

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Program Description	Program Degree	Student Learning Outcomes
BIOLOGY (CONT'D)	**PHD (CONT'D)**	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: Thoroughly understanding of the principal levels of organization of living organisms.
		2: Students will be able to understand the core competencies relative to molecular and cellular biology and the chemical basis of life, to include: 1. atoms, molecules and chemical bonds 2. biologically important molecules 3. cellular bioenergetics, photosynthesis and respiration
		3: Comprehend principles that govern interaction between and within cells, tissues and organisms.
		4: Understand major principals of the discipline, including proliferation, generation of diversity, and evolution by natural selection.
		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.
		6: The initial course in the TUteach major sequence, each student will have developed and implemented four (4) STEM lessons in local k-8 classrooms (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions). The learning outcomes will be supported by the assistance of the school (Mentor) teacher and SCTC 1389 course Instructor. The learning outcomes of the latter course ((MGSE 2189-Classroom Interactions) is also supported by TUteach Faculty Advising. Students will ultimately illustrate proficiency with the completion of courses that reflect successful matriculation of major and foundational General Education requirements, and attain TUteach Candidacy.
		7: 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. Upon completion of the culminating Apprentice Teaching field experience, students will be able to demonstrate mastery of STEM content in the discipline, proficiency with the independent development of curriculum and the delivery of content in a (5E Model) pedagogical sequence. Successful completion of the Apprentice Teaching and Seminar experience (or equivalency) is the final requirement for degree completion.
		8: Communicate using oral, written, or electronic media, and understand attribution and acknowledgement of sources Students will be able to understand and articulate Biology content via various communicable sources: The learning outcomes will be delivered via oral, written and technological platforms. The learning outcomes are further attained by the student's ability to deliver content to a population of (7-12) grade level learners.
BIOLOGY/NEUROSCIENCE	**PHD**	See Biology Ph.D.

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Program Description	Program Degree	Student Learning Outcomes
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**	Introduction to new and emerging innovation in the Biotech sector
		Train in Applied Ethics so that as future leaders candidates will use a broadly accepted ethical framework to assess dilemmas and will do so with highest level of integrity.
		Candidates will be trained in written and oral presentation of scientific work.
		Candidates will be trained in documenting observations and anlayzing results obtained in the laboratory. Students will also use scientific publicaitons to develop critical thinking.
		As future leaders student will be given opportunities to particpiate in professional development. Working as a team students will initiate and organize seminars and meetings with external advisors. Students will seek mentoring opprtunities with leaders in the field.
		To be real-world ready opportunies will be made so students can leverage the powerful impact of teamwork.
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
		4: Proficiency in collecting, analyzing, documenting and validating data
		5: Leadership abilities to contribute effectively within the profession (e.g., lead lab teams, make development and planning decisions, lead in management and marketing decisions)
		6: Develop teamwork skills
CHEMISTRY	**BA**	Students who earn a BA Chemistry degree must know foundational material in the field of chemistry. This comes as a result of successfully completing the coursework necessary to learn chemistry.
		Students who graduate with a BA degree in chemistry will have laboratory skills in a 4 of the 5 subdivisions (analytical, biochemical, inorganic, physical, and organic chemistry) of chemistry. These lab skills will be a result of taking challenging upper level lab courses.

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Program Description	Program Degree	Student Learning Outcomes
CHEMISTRY (CONT'D)	**BA (CONT'D)**	Students who earn a chemistry degree must have developed problem-solving skills. This is central to all science degrees and a necessary skill set for all science related professions. It is a component of all critical thinking centered courses. Problem-solving skills include (but are not limited to) the ability to use data analysis in order to make logical conclusions concerning chemical reactivity and/or chemical properties.
		Students who graduate with a BA degree in chemistry will be able to access chemical literature using library resources and online platforms.
		We must have students learn safety skills in chemistry laboratory settings. This is an essential part of the education process.
		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 in the chemistry field.
CHEMISTRY	**BS**	Students who earn a BS in chemistry must know foundational and in-depth material in the field of chemistry. This knowledge is gained from the coursework necessary to for the chemistry degree.
		Students who graduate with a BS degree in chemistry need to have learned laboratory skills that allow them to analyze and predict chemical principles. They might not need to use these skills in their future positions, but they must understand the fundamentals of chemical analysis when applied to organic, inorganic, physical, and biochemical problems. But they will need to know the equipment and techniques (IR, NMR, UV, etc.) that are used in the chemistry field. They need to have a solid chemistry background and they must have exposure to each of the areas of chemistry.
		Students who earn a chemistry degree must have developed problem-solving skills. This is central to all science degrees and a necessary skill set for all science-related professions. It is a component of all critical thinking centered courses. They need to have the ability to: (i) think critically on their own, (ii) design and execute experiments, (iii) perform data analysis, and (iv) develop testable hypotheses.
		Students need to be able to read the scientific literature in order to become professionals in the fields of chemistry. Students who become chemists will need to have the ability to read scientific articles and write scientific reports.
		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 chemist. There are many students who obtain a chemistry degree as a step toward a health profession goal (pre-med, pre-dent, pre-pharm). It is obvious that these students do not need the same level of research training. Not all chemistry majors are going to become chemists. Those who do become chemists need to know how to develop and explore a research problem in order to be prepared for a career in chemistry or a chemistry-related area.

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Program Description	Program Degree	Student Learning Outcomes
CHEMISTRY (CONT'D)	**BS (CONT'D)**	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 in the chemistry field.
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 their 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/writing of articles for publication in one of the many peer-reviewed journals devoted to their subdiscipline
CHEMISTRY	**PHD**	1: Know the basic principles of their 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/writing of articles for publication in one of the many peer-reviewed journals devoted to their subdiscipline
CHEMISTRY WITH TEACHING	**BS**	The initial course in the TUteach major sequence, each student will have developed and implemented four (4) STEM lessons in local k-8 classrooms (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions). The learning outcomes will be supported by the assistance of the school (Mentor) teacher and SCTC 1389 course Instructor. The learning outcomes of the latter course ((MGSE 2189-Classroom Interactions) is also supported by TUteach Faculty Advising. Students will ultimately illustrate proficiency with the completion of courses that reflect successful matriculation of major and foundational General Education requirements, and attain TUteach Candidacy.
		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. Upon completion of the culminating Apprentice Teaching field experience, students will be able to demonstrate mastery of STEM content in the discipline, proficiency with the independent development of curriculum and the delivery of content in a (5E Model) pedagogical sequence. Successful completion of the Apprentice Teaching and Seminar experience (or equivalency) is the final requirement for degree completion.

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Program Description	Program Degree	Student Learning Outcomes
CHEMISTRY WITH TEACHING (CONT'D)	**BS (CONT'D)**	Students will be able to access chemical literature using library resources and online platforms. Students will be able to grasp core competencies and Chemical Concepts, to include: chemical formulas and nomenclature, chemical reactions and stoichiometry, mixtures, solutions solubility and chemical equilibrium.
		Have laboratory skills in a broad range of subdivisions through laboratory experience in 4 of 5 chemistry subdivisions. The student learning outcomes will incorporate extensive laboratory activities, to include: reinforcement or extension of chemical theory, experimental design, data collection, analysis and interpretation; methods of preparation, use, storage and disposal of reagents conforming to state and federal regulations; laboratory safety.
		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. Students will be able to grasp and understand the breadth of each foundational subdivision, namely: Applications of Chemistry (life sciences and earth sciences); Atomic Theory (atomic structure and nuclear chemistry; electronic configuration and periodicity; chemical bonding and molecular structure. Inorganic chemistry, to include: descriptive chemistry of metallic and non-metallic elements and their industrial importance; valence bond and molecular orbital theories; group theory and crystal systems; chemistry of inorganic complexes; Organic Chemistry: bonding and structure; nomenclature and stereochemistry; reactions and mechanism; synthesis and spectroscopy; industrial chemistry and material science; Physical Chemistry: Thermodynamics and kinetics of chemical reactions, including- laws of thermodynamics; chemical equilibrium; electrochemistry; chemical kinetics.
		Students will be able to gain extensive laboratory skills, to include: reinforcement or extension of chemical theory; experimental design, data collection analysis and interpretation; methods of preparation, use, storage and disposal of reagents conforming to state and federal regulations.
		Students will be able to incorporate and apply problem-solving skills, to include the ability to use data analysis in order to make logical conclusions concerning chemical reactivity and/or properties.
COMPUTATIONAL DATA SCIENCE	**MS**	Exhibit mastery of advanced data structures, algorithms and protocols used in computing applications.
		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, net- working and operating systems)
		Show the ability to apply theoretical and conceptual knowledge to address CS related prob- lems and for mission critical applications.
		Be able to do independent critical thinking, to identify pertinent research and be able to identify the best possible tools or methods with multiple plans to accomplish the goals.

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Program Description	Program Degree	Student Learning Outcomes
COMPUTATIONAL DATA SCIENCE (CONT'D)	**MS (CONT'D)**	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 mastery of advanced data structures, algorithms and protocols used in computing applications.
		After completing this program, students should be able to model real-life phenomena and analyze real-life arbitrarily large datasets under time constraints and uncertain conditions.
		Exhibit familiarity with specific area of CS (e.g. cloud computing, machine learning, net- working and operating systems)
		Show the ability to apply theoretical and conceptual knowledge to address CS related prob- lems and for mission critical applications.
		Be able to do independent critical thinking, to identify pertinent research and be able to identify the best possible tools or methods with multiple plans to accomplish the goals.
		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**	Certificate Program aligns with the Computer Science BS degree program.
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**	Certificate Program aligns with the Data Science BS degree program.
EARTH AND SPACE SCIENCE WITH TEACHING	**BS**	Students will be able to acquire a strong foundational knowledge earth science. As one of the core competencies in the discipline (earth science), the concepts and learning goals are inclusive of the following: Physical Geology: flow of water-hydrologic cycle; characteristics, origin and formation of minerals and rocks; internal structure and processes of the earth; Environment: natural resources and the social impact created by humans and natural activities.
		Students will be able to develop desired, communicable soft skills that are employable in earth science-related fields and/or further their education in graduate or professional school programs.
		Students will be able to design experiments, use probes and computers to gather and analyze data. Further, students will be able to answer scientific questions, reduce systematic and random errors, and use statistics to interpret the results and deal with sampling errors.
		Students can find, read, review and report on articles in the scientific literature. Students will further be able to convey information and literacy as a learning goal via the effective use of technology/technology sources in a virtual (online) platform.

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Program Description	Program Degree	Student Learning Outcomes
EARTH AND SPACE SCIENCE WITH TEACHING (CONT'D)	**BS (CONT'D)**	Students will be able to apply and model math principles to explain scientific phenomena in a project-based learning environment. .
		Students will be able to present research results in oral and written form. The student learning goals are further evidenced by their ability to deliver written and oral presentations in an virtual, online environment.
		The initial course in the TUteach major sequence, each student will have developed and implemented four (4) STEM lessons in local k-8 classrooms (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions). The learning outcomes will be supported by the assistance of the school (Mentor) teacher and SCTC 1389 course Instructor. The learning outcomes of the latter course ((MGSE 2189-Classroom Interactions) is also supported by TUteach Faculty Advising. Students will ultimately illustrate proficiency with the completion of courses that reflect successful matriculation of major and foundational General Education requirements, and attain TUteach Candidacy.
		Upon completion of the culminating Apprentice Teaching field experience, students will be able to demonstrate mastery of STEM content in the discipline, proficiency with the development of curriculum and the delivery of content in a (5E Model) pedagogical sequence. Successful completion of the Apprentice Teaching and Seminar experience (or equivalency) is the final requirement for degree completion.
ENVIRONMENTAL PROFESSIONAL TRAINING	**CERT**	Certificate Program aligns with the Geology BS and Environmental Science BS degree programs.
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**	Certificate Program aligns with the Computer Science and Information Science & Technology BS degree programs.

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GENERAL SCIENCE WITH TEACHING	**BS**	The initial course in the TUteach major sequence, each student will have developed and implemented four (4) STEM lessons in local k-8 classrooms (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions). The learning outcomes will be supported by the assistance of the school (Mentor) teacher and SCTC 1389 course Instructor. The learning outcomes of the latter course ((MGSE 2189-Classroom Interactions) is also supported by TUteach Faculty Advising. Students will ultimately illustrate proficiency with the completion of courses that reflect successful matriculation of major and foundational General Education requirements, and attain TUteach Candidacy.
		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. Upon completion of the culminating Apprentice Teaching field experience, students will be able to demonstrate mastery of STEM content in the discipline, proficiency with the independent development of curriculum and the delivery of content in a (5E Model) pedagogical sequence. Successful completion of the Apprentice Teaching and Seminar experience (or equivalency) is the final requirement for degree completion.
		By the end of degree, the student learning outcomes will be attained through a rich, "General" breadth of knowledge across the sciences, to include sequenced coursework in Biology, Chemistry, Earth & Space Science and Physics. These incorporated learning outcomes are also illustrated though project-based learning and teaching pedagogy. Specifically, the student learning outcomes are outlined as follows: Biology: Life Science, including evolution and diversity of life, plants and animals; Chemistry: Physical Science, to include matter and energy, chemical periodicity and chemical reactions, solutions and solubility; Earth Science: Historical and physical geology, structure of the earth, oceanography, meteorology and astronomy; Physics: kinematics, dynamics, Kinetic Theory, heat, laws of thermodynamics, electricity, magnetism, optics, modern physics. * Reference the New Student Learning Outcome (2020-2021 Academic Year) students will be able to demonstrate effective use of technology/technology sources to grasp course concepts and learning goals in a virtual (online) platform. This student learning outcome (SLO) is exhibited across the curriculum.
GENOME MEDICINE	**CERT**	Refer to Biology BS
GENOMIC MEDICINE	**BS**	Thoroughly understand of the principal levels of organization of living organisms
		Understand the biochemical and biophysical principles that underlie living organisms and diseases
		Communicate using oral, written, or electronic media, and understand attribution and acknowledgement of sources
		Critically evaluate experimental data and be familiar with computational and laboratory procedures
		Understand the role of genomes and evolution in disease and medicine.

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GENOMIC MEDICINE (CONT'D)	**BS (CONT'D)**	Understand major principals of the discipline, such as proliferation, generation of diversity, evolution by natural selection
		Comprehend principles that govern interaction between and within cells, tissues, and organisms
		Learn about the interplay of genomics and medicine with informatics and evolution
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
		4: 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
		4: Demonstrate competence in scientific inquiry, writing, and oral presentation
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 student'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.

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Program Description	Program Degree	Student Learning Outcomes
GEOLOGY (CONT'D)	**MS (CONT'D)**	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 student'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**	Students acquire knowledge of architecture of high-performance computing systems,
		Students prove understanding of mathematical techniques employed in high-performance computing,
		Students acquire understanding of the software tools used in parallel calculations.
		Students acquire general understanding of computational methods used in the sciences and engineering
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 communicate effectively about concepts within the computing discipline.
		Students will be able to effectively work as part of a team to design software systems
		Students will be able to acquire, model, organize, and present data
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 acquire, model, organize, and present data

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Program Description	Program Degree	Student Learning Outcomes
INFORMATION SCIENCE & TECHNOLOGY (CONT'D)	**BS (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	**MS**	SLO 1: Have depth of knowledge of Information Science and Technology Principles. To provide an opportunity for students without a background in programming and/or computer science to gain an understanding of the core Information Science and Technology principles.
		SLO 2: Use, develop, design, and evaluate information technology products and services. Students will be able to use their knowledge of IS&T to apply (Practical thinking), and design new (creative thinking) IS&T products and services
		SLO 3: Organize and manage a team of technical and non-technical audiences developing information technology products. To provide students from a variety of backgrounds (including biology, chemistry, engineering, business, social sciences, and arts) with the opportunity to learn how to communicate with technical and non-technical audiences about information technology concepts and how to assume leadership roles.
		SLO 4: Evaluate, compare, and select from alternative and emerging information technologies. The students will have the opportunity to enhance their Practical Thinking and gain experience in evaluating emerging information technologies.
		SLO 5: Pursue professional development to meet the demands of their new and challenging IS&T career. To provide students with the opportunity to learn skills for computing-focused jobs in software application development, including web and mobile application development, software testing and quality assurance, database management, information security, and computer networking, as well as jobs that are at the interface of discipline-specific knowledge and computing.
INFORMATION SCIENCE AND TECHNOLOGY	**GRAD**	Certificate Program aligns with the Information Science & Technology MS degree program.
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.

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Program Description	Program Degree	Student Learning Outcomes
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.
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.
		4: Effectively process and evaluate both theoretical and real-life quantitative data.
		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).
MATHEMATICS	**PHD**	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.
		4: Formulate a research problem as a mathematical conjecture and design a long-range strategy for attacking this.

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Program Description	Program Degree	Student Learning Outcomes
MATHEMATICS (CONT'D)	**PHD (CONT'D)**	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: Conduct independent research.
		7: Develop mastery as an instructor at the collegiate level.
MATHEMATICS AND COMPUTER SCIENCE WITH TEACHING	**BS**	The initial course in the TUteach major sequence, each student will have developed and implemented four (4) STEM lessons in local k-8 classrooms (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions). The learning outcomes will be supported by the assistance of the school (Mentor) teacher and SCTC 1389 course Instructor. The learning outcomes of the latter course ((MGSE 2189-Classroom Interactions) is also supported by TUteach Faculty Advising. Students will ultimately illustrate proficiency with the completion of courses that reflect successful matriculation of major and foundational General Education requirements, and attain TUteach Candidacy.
		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. Upon completion of the culminating Apprentice Teaching field experience, students will be able to demonstrate mastery of STEM content in the discipline, proficiency with the independent development of curriculum and the delivery of content in a (5E Model) pedagogical sequence. Successful completion of the Apprentice Teaching and Seminar experience (or equivalency) is the final requirement for degree completion.
		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. Student learning outcomes are further evidenced by understanding and assessment of these concepts in a virtual (online) environment.
		Students will be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability. Student learning outcomes are further evidenced by understanding and successful assessment of these concepts and learning goals in a virtual (online) environment.
		Upon completion of the program, students will be be able to effectively communicate mathematical ideas using oral, written, and/or electronic media. The student learning outcomes are further evidenced by understanding and successful assessment of these concepts and learning goals.
		After completing this program, students should be able to use technological tools that are useful in mathematical research. The effective use of technology is further evidenced by each student's ability to satisfy learning goals in an virtual, online environment.

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Program Description	Program Degree	Student Learning Outcomes
MATHEMATICS AND COMPUTER SCIENCE WITH TEACHING (CONT'D)	**BS (CONT'D)**	Upon completion of the program, students will be able to think critically and apply multiple approaches to solving problems. The student learning outcomes are further evidenced by the successful assessment of this learning goal.
		Upon completion of this program, students will illustrate mathematical independence and have use open-ended inquiry to solve problems.
MATHEMATICS AND TECHNOLOGY WITH TEACHING	**BS**	The initial course in the TUteach major sequence, each student will have developed and implemented four (4) STEM lessons in local k-8 classrooms (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions). The learning outcomes will be supported by the assistance of the school (Mentor) teacher and SCTC 1389 course Instructor. The learning outcomes of the latter course ((MGSE 2189-Classroom Interactions) is also supported by TUteach Faculty Advising. Students will ultimately illustrate proficiency with the completion of courses that reflect successful matriculation of major and foundational General Education requirements, and attain TUteach Candidacy.
		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. Upon completion of the culminating Apprentice Teaching field experience, students will be able to demonstrate mastery of STEM content in the discipline, proficiency with the independent development of curriculum and the delivery of content in a (5E Model) pedagogical sequence. Successful completion of the Apprentice Teaching and Seminar experience (or equivalency) is the final requirement for degree completion.
		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. Student learning outcomes are further evidenced by understanding and assessment of these concepts in a virtual (online) environment.
		Students will be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability. Student learning outcomes are further evidenced by understanding and successful assessment of these concepts and learning goals in a virtual (online) environment.
		Upon completion of the program, students will be be able to effectively communicate mathematical ideas using oral, written, and/or electronic media. The student learning outcomes are further evidenced by understanding and successful assessment of these concepts and learning goals.
		After completing this program, students should be able to use technological tools that are useful in mathematical research. The effective use of technology is further evidenced by each student's ability to satisfy learning goals in an virtual, online environment.

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College of Science and Technology
Academic Program Student Learning Outcomes

Program Description	Program Degree	Student Learning Outcomes
MATHEMATICS AND TECHNOLOGY WITH TEACHING (CONT'D)	**BS (CONT'D)**	Upon completion of the program, students will be able to think critically and apply multiple approaches to solving problems. The student learning outcomes are further evidenced by the successful assessment of this learning goal.
		Upon completion of this program, students will illustrate mathematical independence and have use open-ended inquiry to solve problems.
MATHEMATICS WITH TEACHING	**BS**	The initial course in the TUteach major sequence, each student will have developed and implemented four (4) STEM lessons in local k-8 classrooms (STEP 1/2) and 3 consecutive STEM lessons in a local 7-12 classroom(Classroom Interactions). The learning outcomes will be supported by the assistance of the school (Mentor) teacher and SCTC 1389 course Instructor. The learning outcomes of the latter course ((MGSE 2189-Classroom Interactions) is also supported by TUteach Faculty Advising. Students will ultimately illustrate proficiency with the completion of courses that reflect successful matriculation of major and foundational General Education requirements, and attain TUteach Candidacy.
		Upon completion of the culminating Apprentice Teaching field experience, students will be able to demonstrate mastery of STEM content in the discipline, proficiency with the independent development of content in a (5E Model) pedagogical sequence. Successful completion of the Apprentice Teaching and Seminar experience (or equivalency) is the final requirement for degree completion.
		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. Student learning outcomes are further evidenced by understanding and assessment of these concepts in a virtual (online) environment.
		Students will be able to carry out rigorous arguments in the context of real and complex analysis, abstract algebra, and probability. Student learning outcomes are further evidenced by understanding and successful assessment of these concepts and learning goals in a virtual (online) environment.
		Upon completion of the program, students will be be able to effectively communicate mathematical ideas using oral, written, and/or electronic media. The student learning outcomes are further evidenced by understanding and successful assessment of these concepts and learning goals.
		After completing this program, students should be able to use technological tools that are useful in mathematical research. The effective use of technology is further evidenced by each student's ability to satisfy learning goals in an virtual, online environment.
		Upon completion of the program, students will be able to think critically and apply multiple approaches to solving problems. The student learning outcomes are further evidenced by the successful assessment of this learning goal.
		Upon completion of this program, students will illustrate mathematical independence and have use open-ended inquiry to solve problems.

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Program Description	Program Degree	Student Learning Outcomes
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.
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.
NATURAL SCIENCES	**BS**	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 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.

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Program Description	Program Degree	Student Learning Outcomes
NATURAL SCIENCES (CONT'D)	**BS (CONT'D)**	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. critically evaluate experimental data and be familiar with laboratory procedures, particularly those related to Neuroscience
		5. 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
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: have appropriate laboratory skills for the analysis of physical systems. These include data and error analysis, instrumentation, radiation detection, counting statistics, and dimensional analysis.

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Program Description	Program Degree	Student Learning Outcomes
PHYSICS (CONT'D)	**BS (CONT'D)**	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
PHYSICS	**MS**	The fundamental physics of the core courses Analytical Mechanics, Mathematical Physics, Quantum Mechanics I & II, Electromagnetic Theory, Statistical Mechanics, and Physics Research & Ethics.
		solving physical and mathematical problems, and other problems whose solution requires logic, knowledge, creativity, and self-discipline
		creation of new knowledge in a thesis or research article
		advanced fundamental physics, as taught in the Solid State Physics, Nuclear & Elementary Particle Physics courses, and advanced elective courses like Many-Electron Theory and Advanced Topics in Nuclear & Elementary Particle Physics
PHYSICS	**PHD**	Fundamental physics as taught in the core courses Analytical Mechanics, Mathematical Physics, Quantum Mechanics I & II, Electromagnetic Theory, Statistical Mechanics, and Physics Research & Ethics. Nearly all our students have already had an introduction to most of these subjects as undergraduates, but at the graduate level they acquire a deeper, broader, and more abstract understanding of the fundamental principles of physics.
		Solving physical or mathematical problems, or other problems whose solution requires logic, knowledge, creativity, and self-discipline
		creating new knowledge via a dissertation or research journal article
		Advanced fundamental physics as taught in the Solid state Physics and Nuclear and Elementary Particle Physics courses, or in advanced elective courses like Many-Electron Physics, Advanced Nuclear and Elementary Particle Physics and Quantum Field Theory. Students take these courses in their second year, when they are also sampling or starting graduate research.
PHYSICS WITH TEACHING	**BS**	Students will be able to understand fundamental principles of physics and apply these principles to the following Core Competencies: classical mechanics, electromagnetism, optics and wave phenomena, thermodynamics and statistical mechanics, quantum mechanics, atomic physics, special relativity, and specialized topics.
		Students will demonstrate the appropriate laboratory skills for the analysis of physical systems. These include data and error analysis, instrumentation, radiation detection, counting statistics, and dimensional analysis.

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Program Description	Program Degree	Student Learning Outcomes
PHYSICS WITH TEACHING (CONT'D)	**BS (CONT'D)**	Students will be able to use use mathematical methods to study physical models. Relative to the cross-curricular relationship math has to understanding the Physics Core Competencies, these mathematical methods include the following: 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.
		Students will be able to exhibit effective oral and written communications skills within the context of explaining their work to a broad and diverse audience. For the 2020-2021 Academic Year, students will also be able to demonstrate effective use of technology/technology sources to grasp course concepts and learning goals in a virtual (online) platform. This student learning outcome (SLO) is exhibited across the curriculum.
		Students will have a basic understanding of STEM principles across the sciences. This will include the breadth of Natural Sciences, chemistry, biology and geology. The student learning outcome(s) will also reflect their ability to apply these principles to solve real-world problems.
		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 course Instructor. Upon completion of the culminating Apprentice Teaching field experience, students will be able to demonstrate mastery of STEM content in the discipline, proficiency with the independent development of curriculum and the delivery of content in a (5E Model) Instructional sequence. Successful completion of the Apprentice Teaching and seminar experience (or equivalency) is the final requirement to degree completion.
		Upon completion of the culminating Apprentice Teaching field experience, students will be able to demonstrate mastery of STEM content in the discipline, proficiency with the independent development of curriculum and the effective delivery of content in a (5E Model) instructional sequence. Successful completion of the Apprentice Teaching and Seminar experience (or equivalency) is the final requirement for degree completion.
SCIENTIFIC WRITING	**GRAD**	Knowledge of the basic principles and practices of the different genres of Scientific Writing
		An understanding of the process of research and development in academia and industry
		An understanding of, and the expertise to effectively use the wide variety of funding sources for academic and non-profit/not-for-profit projects
		Increased skills in editing, storytelling, research, and analysis
		Broadened knowledge of career opportunities in Scientific Writing
SCIENTIFIC WRITING	**PSM**	Knowledge of the basic principles and practices of the different genres of Scientific Writing
		An understanding of the process of research and development in academia and industry
		Increased skills in editing, storytelling, research, and analysis

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Program Description	Program Degree	Student Learning Outcomes
SCIENTIFIC WRITING (CONT'D)	**PSM (CONT'D)**	Broadened knowledge of career opportunities in Scientific Writing
		An understanding of, and the expertise to effectively use the wide variety of funding sources for academic and non-profit/not-for-profit projects