New AST Ph.D. Curriculum Guide Effective 2020-2021

Applied Science and Technology, Ph.D.

College of Science and Technology
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The mission of the Applied Science & Technology Ph.D. program is to prepare students for high-level science and technology careers in industry, research, and government. Graduates will be able to conceive, develop, and conduct original research that applies physical, mathematical, and technological methods to provide solutions to a broad range of emerging local, national, and global problems related to Atmospheric, Environmental and Energy Science; Applied Physics; Bioscience; Applied Chemistry; Data Science and Analytics; Applied Engineering Technology; Information Technology; Technology Management; Geomatics; and STEM Education.

Admission Requirements
- B.S. degree in a science, technology, engineering, math (STEM) or related discipline with a GPA≥3.25/4.0 or a M.S. degree in a science, technology, engineering, math (STEM) or related discipline with a GPA≥3.0/4.0 from a college or university recognized by a regional or general accrediting agency
- GRE verbal and quantitative scores, no minimum score requirement

Program Outcomes
- Communication Skills – Students completing the Applied Science & Technology Ph.D. program will exhibit effective oral communication skills in terms of customizing presentations to the audience, displaying information, and delivering the presentations.
- Critical Thinking Skills - Students completing the Applied Science & Technology Ph.D. program will effectively use quantitative and qualitative analytical problem-solving skills in terms of defining hypotheses/research questions, reviewing research literature, developing a research plan, identifying the broader impacts of research, and developing a research timetable.
- Disciplinary Expertise - Students completing the Applied Science & Technology Ph.D. program will demonstrate discipline-specific expertise in terms of the scientific method, applying technical knowledge to answer research questions, experimental plans and data analysis, analytical methods, and research ethics.
- Research/Creative Engagement - Students completing the Applied Science & Technology Ph.D. program will demonstrate ability to engage productively in the review and conduct of disciplinary research in terms of making conference presentations and publishing refereed journal publications.

Degree Requirements
Total credit hours: 66 (post B.S.), 42 (post M.S.)
- Core courses (9 credits): AST 830 (Foundations of Scientific Research), AST 831 (Math and Computational Modeling) or other graduate analytical modeling course that builds upon a student's previous background, MATH 721 (Multivariate Statistical Analysis) or other graduate statistics course that builds upon a student's previous background
- Seminar (6 credits post B.S., 3 credits post M.S.): AST 992 (Doctoral Seminar)
- Dissertation (21 credits post B.S., 15 credits post M.S.): AST 997 (Doctoral Dissertation)
- Pass qualifying exam, preliminary exam, and dissertation defense
- In consultation with advisor, take 18 credit hours (15 post M.S.) within one of the following concentrations:
  - Applied Chemistry

- o   Applied Physics
- o   Atmospheric, Environmental and Energy Science
- o   Bioscience
- o   Data Science and Analytics
- o   Information Technology
- o   Technology Management
- o   STEM Education
- o   General – no specified concentration
- In consultation with advisor, take 12 credit hours (post B.S.) of additional courses relevant to research area

Concentration Courses

For each program concentration, students will typically take courses that are included in the following lists with additional courses possible with approval of research adviser and program director:

Applied Chemistry

CHEM 611	Advanced Inorganic Chemistry
CHEM 621	Intermediate Organic Chemistry
CHEM 624	Qualitative Organic Chemistry
CHEM 631	Electroanalytical Chemistry
CHEM 641	Instrumentation of the Modern Sciences
CHEM 642	Techniques in X-ray Crystallography
CHEM 643	Introduction to Quantum Mechanics
CHEM 651	General Biochemistry
CHEM 652	General Biochemistry Lab
CHEM 673	Introduction to Computational Chemistry
CHEM 674	Computational Methods/Protein Modeling Drug Design
CHEM 716	Selected Topics in Inorganic Chemistry
CHEM 722	Advanced Organic Chemistry
CHEM 732	Advanced Analytical Chemistry
CHEM 743	Chemical Thermodynamics
AST 812	Environmental Chemistry
BMEN 711	Biomaterials and Biocompatibility
ECEN 701	Electronic Ceramics
NANO 701	Simulation Modeling Methods in Nanoscience and Nanoengineering
NANO 702	Fundamentals of Nanoengineering Physical Principles
NANO 703	Fundamentals of Nanoengineering Chemical and Biochemical Principles
NANO 704	Fundamentals of Nanomaterials
NANO 705	Nano Safety
NANO 711	Introduction to Nanoprocessing
NANO 721	Nanobioelectronics
NANO 731	Introduction to Nanomodeling and Applications
NANO 811	Polymeric Materials Engineering
NANO 812	Process Modeling in Composites
NANO 821	Advanced Nanosystems
NANO 851	Computational Nano Modeling Lab
NANO 852	Nanoelectronics Laboratory
NANO 853	Nano-Bio Electronics Lab
NANO 854	Nanomaterials Laboratory
NAN 601	Nanochemistry
CHEM 811	Physical Methods for Inorganic Chemistry

CHEM 812   Inorganic Chemical Kinetics and Mechanisms
CHEM 818   Introduction to Soft Matter
CHEM 823   Integrative Medicinal Chemistry
CHEM 827   Organic Structural Spectroscopy
CHEM 833   Biosensors and Bioanalytical Technologies
CHEM 841   Advanced Mass Spectrometry Instrumentation
CHEM 856   Protein Structure and Function
CHEM 885   Special Topics
NAN   615   Intro Spectroscopy Methods in Nanoscience
NAN   630   Advances in Nano-biosensors
NAN   705   Macromolecular and Supramolecular Chemistry Nanoscience
NAN   730   Nanoscale Reactions
NAN   771   Computational Quantum Nanochemistry

Applied Physics
PHYS   600   Classical Mechanics
PHYS   605   Mathematical Methods
PHYS   615   Fundamentals of Electromagnetic Theory
PHYS   620   Quantum Mechanics I
PHYS   630   Statistical Mechanics
PHYS   715   Advanced Electromagnetic Theory
PHYS   720   Quantum Mechanics II
PHYS   730   Optical Properties of Matter
PHYS   737   Physics of Solids
PHYS   738   Nuclear Physics
PHYS   745   Computational Physics
PHYS   746   Methods in Radiation Detection and Measurement
PHYS   843   Experimental Methods
PHYS   850   Quantitative Analysis in Biophysics
PHYS   885   Special Topics
NAN   603   Nanophysics

Atmospheric, Environmental and Energy Science
AST   812   Environmental Chemistry
AST   813   Sustainable Energy Systems
AST   814   Life Cycle Analysis
AST   821   Environmental Energy Econometrics I
AST   841   Biomaterials Characterization
AST   842   Biomass Thermal Conversion Processes
AST   843   Biomass Biological Conversion Processes
AST   844   Environmental and Policy Studies of Biomass Use
AST   850   Physical Meteorology
AST   851   Dynamic Meteorology
AST   852   Climatology
AST   853   Numerical Weather Prediction
AST   854   Advanced Synoptic Weather Analysis
AST   855   Principles of Air Quality
AST   856   Atmospheric Aerosols
AST   857   Advanced Remote Sensing
AST   858   Tropical Meteorology
AST   859   Advanced Mesoscale Analysis

AST	885	Special Topics
NANO	761	Introduction to Nano Energy
NANO	861	Advanced Nano Energy Systems
CM	704	Special Topics in Renewable Energy Technology
CM	679	Environmental Issues in Construction Management
EPT	687	Electrical Power Generation using Nuclear Technology

Bioscience

BIOL	615	Principles of Virology
BIOL	630	Molecular Genetics
BIOL	640	Introduction to Bioinformatics and Genomic Research
BIOL	651	Principles and Practice of Immunology
BIOL	700	Environmental Biology
BIOL	703	Experimental Methods Biology
BIOL	704	Cell and Molecular Biology
BIOL	720	Environmental Influences
BIOL	749	Recent Advances in Cell Biology
BIOL	762	Molecular Pathogenesis of Cancer
AST	843	Biomass Biological Conversion Processes
ANSC	771	Bioinformatics Genome Analysis
ANSC	782	Cellular Pathobiology
BMEN	713	Biotechnology Entrepreneurship
BIOL	830	Advanced Techniques in Integrative Biosciences
BIOL	831	Cellular and Molecular Biology of Disease
BIOL	832	Microbial Pathogenesis
BIOL	833	Recent Advances in Immunology
BIOL	834	General Physiology I
BIOL	835	General Physiology II
BIOL	855	Advances in Systems Biology
BIOL	885	Special Topics
STAT	824	Biostatistics Health Analytics
NAN	602	Nanobiology
NAN	620	Immunology Nanoscience
NAN	625	Molecular Biology in Nanosciences
NAN	626	Introduction to Stem Cell Biology and Ethics
NAN	745	Nanoimaging
NAN	750	Nanomedicine

Data Science and Analytics

MATH	612	Advanced Linear Algebra
MATH	623	Probability Theory and Applications
MATH	624	Theory and Methods of Statistics
MATH	665	Principles of Optimizations
MATH	675	Graph Theory
MATH	690	Scientific Programming for Mathematical Scientists
MATH	706	Categorical Data Analysis
STAT	707	Introduction to Data Science
STAT	708	Linear Models for Data Science
MATH	709	Disc and Combi Math for Data Sci
STAT	710	Statistical and Deep Learning
STAT	711	Stat Comp & Algorithm Analysis

MATH 712 Numerical Linear Algebra
STAT 719 Statistical Computing and Algorithm Design & Analysis
MATH 721 Multivariate Statistical Analysis
MATH 723 Advanced Topics Stochastic Modeling
MATH 733 Advanced Probability and Stochastic Processes
MATH 782 Statistical Data Analytics and Visualization
CST 764 Advanced Big Data Analytics
COMP 751 Data Analytics Tools and Techniques
COMP 765 Data Mining
STAT 777 The Practice of Stat Consulting
STAT 808 Advanced Regression Methods for Data Science
STAT 823 Time Series Analysis Business Analytics
STAT 824 Biostatistics Health Analytics
MATH 885 Special Topics
NAN 605 Mathematical Methods

Information Technology
CST 700 Project Management for IT Professionals
CST 702 Statistical Methods
CST 714 Reconfigurable Computing
CST 717 Health Informatics System Architecture
CST 725 Wide Area Networks
CST 729 Data Warehousing
CST 731 Knowledge Discovery Systems
CST 732 Text Mining
CST 733 Data Visualizations
CST 735 Telecom Management Issues
CST 745 Network Services for the Enterprise
CST 750 Computer System Security
CST 752 Advanced Computer Forensics
CST 755 Enterprise Management Systems
CST 760 Intermediate Enterprise Systems
CST 764 Advanced Big Data Analytics
CST 765 Advanced Enterprise System Operation
CST 770 Survey of Virtualization Technology
CST 850 Advanced Wireless Communication Systems
CST 855 Advanced Optical Communication Systems
CST 885 Special Topics
COMP 727 Secure Software Engineering
COMP 823 Secure Social Computing
CSE 703 Data Structure Software Principles & Programming
CSE 806 Computational System Theory

Technology Management
AET 710 Manufacturing Materials
AET 720 Industrial Economics
AET 721 Industrial Operational Management
AET 735 Manufacturing Organization and Management
AET 745 Managing New Product Development
AET 755 Production Management and Control
AET 760 Advanced CNC Machines

AET	770	Managing Total Quality Systems
AET	772	Strategic Concepts in Quality
AET	780	Reliability Testing and Analysis
AET	810	Project Management Essentials
AET	820	Managing R&D Process
AET	830	Internet of Things Technology
AET	840	Industrial Fire Protection
AET	885	Special Topics
MSTM	701	Strategic Management of Technology and Innovation
MSTM	702	Enterprise Resource Plan Systems
MSTM	703	Statistics and Probability in Technology Management
MSTM	704	Research Methods for Technology Management
MSTM	705	Advanced Applied Statistics and Probability
MSTM	779	Statistical Research in Technology Management
LAND	781	Risk Management in Construction
CM	710	Advanced Construction Practices & Organization
CM	715	Productivity & Methods Improvement in Construction Management
CM	720	Construction Contracts Administration
CM	764	Risk Management in Construction
CM	780	Emerging Trends in CM of International Projects
CM	786	Construction Trends & Analysis
TECH	708	Impacts of Technology
ECEN	885	Advanced Robotic Systems
INEN	833	Supply Chain System Engineering
INEN	861	Nano Micro and Bio Manufacturing

STEM Education
The STEM Education PhD course requirements are:

STEM Education Foundations (9 credit hours) The purpose of the Foundation requirements is to provide a bridge into this interdisciplinary field by integrating STEM and education concepts:

AST	**801**	**History and Philosophy of STEM Education**
AST	**802**	**Theories of Development and STEM Thinking**
AST	**803**	**STEM Education Methods**

STEM Expertise (3 credit hours)
Students are required to complete a coherent sequence of graduate courses in a STEM field other than STEM Education. The purpose of this requirement is to provide depth of understanding of STEM concepts, in particular, STEM concepts that may be the focus of STEM Education research activities.

STEM Education Research Specialization (3 credit hours)
The purpose of the Specialization requirement is to develop depth of knowledge in one area of STEM Education.

AST	**804**	**Cognitive Devices in STEM Learning Environments**
TECH	719	Technology Education: Design in Construction
TECH	720	Technology Education: Design in Manufacturing
TECH	722	Technology Education: Design in Transportation
TECH	730	Diversity Issues in Education and Industry
TECH	762	Evaluation of Technological Education Programs
TECH	763	Technology Education for Elementary Grades

TECH	765	Evaluation of Training in Industrial Settings
TECH	772	Curriculum Development in Technology Education
LEST	860	Qualitative Research
LEST	862	Quantitative Research
LEST	864	Ethnographic Methods in Social Science Research
LEST	865	Mixed Methods Research
ADED	708	Instructional Methods in Adult Education
ADED	719	Assessment and Evaluation
ADED	722	Diverse Perspectives in Adult Education
ADED	776	Principles of College Teaching
CUIN	724	Problems and Trends in Teaching Science
CUIN	727	Workshop Method of Teaching Math
CUIN	753	Teaching Engineering and Technology in Middle School
CUIN	784	Current Research in Secondary Education
AGED	703	Scientific Methods in Education Research I
AGED	704	Foundations and Philosophy of Agricultural Education
AGED	711	Advanced Teaching & Assessment Methodology
AGED	751	Agricultural Education Across the Curriculum
AGED	752	Special Populations in Agricultural Education

General

GEOM	612	Applied Geospatial Mthd Anal
GEOM	620	Advanced Computer Applications in Geomatics
GEOM	640	Applied Adjustment Computation
GEOM	650	Land Information Systems and Management
GEOM	660	Applied Geodetic Measurements
GEOM	670	Advanced Boundary Research
GEOM	710	Geospatial Techniques and Analysis
GEOM	720	Advanced Imaging
GEOM	831	Advanced Geospatial Analysis
GEOM	845	Methodologies of Applied Remote Sensing
GEOM	885	Special Topics
EHS	600	Environmental and Occupational Toxicology
EHS	613	Industrial Hygiene Ventilation
EHS	704	Environmental and Occupational Epidemiology
EHS	708	Environmental and Occupational Safety and Health Management
EHS	711	Current Issues in Environmental and Occupational Health
EHS	885	Special Topics
STAT	824	Biostatistics Health Analytics

Dissertation Research

A student may not register for dissertation credits before passing the Qualifying Examination.

Qualifying Examination

The Qualifying Examination with both written and oral components is given to assess the student's competence in a broad range of relevant subject areas. Only students with unconditional status and in good academic standing may take the Qualifying Examination. No student is permitted to take the Qualifying Examination more than twice. A student not recommended for re-examination or who fails the exam on a second attempt may be dismissed from the doctoral program.

Preliminary Oral Examination

The Preliminary Oral Examination is conducted by the student's dissertation committee and is a written and oral defense of the student's dissertation proposal. Failure on the examination may result in dismissal from the doctoral program. The student's Dissertation Committee may permit one re-examination. At least one full semester must elapse before the re-examination. Failure on the second attempt will result in dismissal from the doctoral program.

Admission to Candidacy
Student will be admitted to candidacy upon successful completion of the Qualifying Exam and the Preliminary Exam. After admission to candidacy and before Final Oral Examination, a student may be dismissed from the doctoral program if the student's dissertation committee determines that the student is not making satisfactory progress.

Final Oral Examination
The Final Oral Examination is conducted by the student's dissertation committee. This examination is the final dissertation defense presentation that is scheduled after a dissertation is completed. The examination may be held no earlier than one semester (or four months) after admission to candidacy. Failure on the examination may result in dismissal from the doctoral program. The student's Dissertation Committee may permit one re-examination. At least one full semester must elapse before the re-examination. Failure on the second attempt will result in dismissal from the doctoral program.

Submission of Dissertation
Upon passing the Ph.D. Final Oral Examination, the Ph.D. student must have the dissertation approved by each member of the student's Dissertation Committee. The approved dissertation must be submitted to The Graduate College by the deadline given in the academic calendar and must conform to the Graduate College's guidelines for theses and dissertations.