New AST Ph.D. Curriculum Guide Effective 2024-2025

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; Geospatial Sciences; 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)
    - STAT 727 Multivariate Statistical Analysis, STAT 705 Applied Statistics for Biological & Behavioral Sciences or STAT 708 Linear Models for Data Science (or other graduate statistics course that builds upon a student's previous background)
- AST 992 Doctoral Seminar: 6 credits post B.S., 3 credits post M.S.
- AST 997 Doctoral Dissertation: 21 credits post B.S., 15 credits post M.S.
- Pass qualifying exam, preliminary exam, and dissertation defense

- In consultation with advisor, take 18 credit hours (15 credits post M.S.) of foundation and elective courses to build expertise and research specialization within one of the following concentrations:
    - Applied Chemistry
    - Applied Physics
    - Atmospheric, Environmental and Energy Science
    - Bioscience
    - Data Science and Analytics
    - Information Technology
    - Technology Management
    - STEM Education
    - 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
The Applied Chemistry Ph.D. concentration course requirements (18 credit hours; 15 credit hours post M.S.) are:

Applied Chemistry Foundation Courses (6 credit hours) The purpose of the Foundation requirements is to provide a framework for foundational concepts:

CHEM 611 Advanced Inorganic Chemistry
CHEM 827 Organic Structural Spectroscopy

Applied Chemistry Expertise & Research Specialization (12 credit hours; 9 credit hours post M.S.): Students are required to complete a coherent sequence of graduate courses in Applied Chemistry. The purpose of this requirement is to provide depth of understanding of Chemistry concepts, in particular, concepts that may be the focus of research activities.

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

Qualifying Examination courses:
The Qualifying Examination will be based on first-year courses (equivalent to 18-20 credit hours), including Foundation Courses.

Applied Physics
The Applied Physics Ph.D. concentration course requirements (18 credit hours; 15 credit hours post M.S.) are:

Applied Physics Foundation Courses (12 credit hours) The purpose of the Foundation requirements is to provide a framework for foundational concepts:

PHYS 600 Classical Mechanics
PHYS 615 Fundamentals of Electromagnetic Theory
PHYS 620 Quantum Mechanics I
PHYS 630 Statistical Mechanics

Applied Physics Expertise & Research Specialization (6 credit hours; 3 credit hours post M.S.):
Students are required to complete a coherent sequence of graduate courses in Applied Physics. The purpose of this requirement is to provide depth of understanding of Physics concepts, in particular, concepts that may be the focus of research activities.

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

Qualifying Examination courses:
The Qualifying Examination will be based on first-year courses (equivalent to 18-20 credit hours), including Foundation Courses.

<u>Atmospheric, Environmental and Energy Science</u>
The Atmospheric, Environmental and Energy Science Ph.D. concentration course requirements (18 credit hours; 15 credit hours post M.S.) are:

Atmospheric, Environmental and Energy Science Foundation Courses (12 credit hours) The purpose of the Foundation requirements is to provide a framework for foundational concepts:

AST 850 Physical Meteorology
AST 851 Dynamic Meteorology
AST 852 Climatology
AST 854 Advanced Synoptic Weather Analysis

Atmospheric, Environmental and Energy Science Expertise & Research Specialization (6 credit hours; 3 credit hours post M.S.):
Students are required to complete a coherent sequence of graduate courses in Atmospheric, Environmental and Energy Science. The purpose of this requirement is to provide depth of understanding of Atmospheric, Environmental and Energy Science concepts, in particular, concepts that may be the focus of research activities.

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
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

Qualifying Examination courses:
The Qualifying Examination will be based on first-year courses (equivalent to 18-20 credit hours), including Foundation Courses.

Bioscience
The Bioscience Ph.D. concentration course requirements (18 credit hours; 15 credit hours post M.S.) are:

Bioscience Foundation Courses (9 credit hours) The purpose of the Foundation requirements is to provide a framework for foundational concepts:
BIOL 730 Evolutionary Medicine
BIOL 749 Recent Advances in Cell biology
BIOL 855 Systems Biology

Bioscience Expertise & Research Specialization (9 credit hours; 6 credit hours post M.S.):
Students are required to complete a coherent sequence of graduate courses in Bioscience. The purpose of this requirement is to provide depth of understanding of Bioscience concepts, in particular, concepts that may be the focus of research activities.

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 on Human Diseases
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	705	Applied Statistics for Biological and Behavioral Sciences
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

Qualifying Examination courses:
The Qualifying Examination will be based on first-year courses (equivalent to 18-20 credit hours), including Foundation Courses.

Data Science and Analytics
The Data Science and Analytics Ph.D. concentration course requirements (18 credit hours; 15 credit hours post M.S.) are:

Data Science and Analytics Foundation Courses (12 credit hours) The purpose of the Foundation requirements is to provide a framework for foundational concepts:
STAT 707 Introduction to Data Science
STAT 708 Linear Models for Data Science
STAT 709 Statistical Foundations of Data Analytics
DAAN 704 Predictive Analytics & Machine Learning or MATH 782 Statistical Data Analytics & Visualization

Data Science and Analytics Expertise & Research Specialization (6 credit hours; 3 credit hours post M.S.):
Students are required to complete a coherent sequence of graduate courses in Data Science and Analytics. The purpose of this requirement is to provide depth of understanding of Data Science and Analytics concepts, in particular, concepts that may be the focus of research activities.

STAT 703 Probability Theory & Application
STAT 704 Theory and Methods of Statistics
STAT 705 Applied Statistics for Biological & Behavioral Sciences
STAT 710 Statistical Deep Learning
STAT 711 Statistical Computing and Algorithm Design & Analysis
STAT 712 Bayesian Statistics
STAT 713 Sampling Survey Methods
STAT 716 Design and Analysis of Educational Experiments
STAT 722 Nonparametric Statistics
STAT 723 Categorical Data Analysis
STAT 727 Multivariate Statistical Analysis
STAT 777 Statistical Consulting Practice
STAT 808 Advanced Regression Methods for Data Science
STAT 810 Causal Inference and Learning
STAT 823 Time Series & Business Analytics
STAT 824 Biostatistics & Health Analytics
DAAN 703 Database Management and Visualization
DAAN 705 Data Privacy, Ethics and Security
DAAN 784 MS Practicum in Data Analytics
MATH 603 Introduction to Real Analysis
MATH 607 Theory of Numbers
MATH 612 Advanced Linear Algebra
MATH 631 Linear & Non-Linear Programming
MATH 633 Stochastic Process
MATH 650 Ordinary Differential Equation
MATH 651 Partial Differential Equations
MATH 652 Methods of Applied Mathematics
MATH 665 Principles of Optimizations
MATH 675 Graph Theory
MATH 685 Special Topics in Applied Mathematics
MATH 690 Scientific Programming for Mathematical Scientists
MATH 691 Special Topics in Applied Mathematics
MATH 700 Theory Function of Real Variables I
MATH 701 Theory Function of Real Variables II
MATH 709 Discrete and Combinatoric Mathematics for Data Science
MATH 711 Theory Function of Complex Variables
MATH 712 Numerical Linear Algebra
MATH 717 Special Topics in Algebra
MATH 720 Special Topics in Analysis
MATH 723 Advanced Topics Applied Mathematics
MATH 731 Advanced Numerical Methods
MATH 733 Advanced Probability & Stochastic Processes
MATH 751 Solution Methods for Integral Equations
MATH 752 Calculus of Variations & Control Theory
MATH 761 Interdisciplinary Computational Science Project I
MATH 762 Interdisciplinary Computational Science Project II
MATH 765 Optimization Theory & Applications
MATH 781 Mathematics & Computational Modeling
MATH 782 Statistical Data Analytics and Visualization
MATH 885 Special Topics in Data Science & Analytics

CST 764 Advanced Big Data Analytics
COMP 751 Data Analytics Tools and Techniques
COMP 765 Data Mining
NAN 605 Mathematical Methods

Qualifying Examination courses:
The Qualifying Examination will be based on first-year courses (equivalent to 18-20 credit hours), including Foundation Courses.

Information Technology
The Information Technology Ph.D. concentration course requirements (18 credit hours; 15 credit hours post M.S.) are:

Information Technology Foundation Courses (12 credit hours) The purpose of the Foundation requirements is to provide a framework for foundational concepts:
CST 605 Principles of Computer Networking or CST 625 Computer Database Management
CST 700 Project Management for IT Professionals
CST 702 Statistical Methods
CST 750 Computer System Security

Information Technology Expertise & Research Specialization (6 credit hours; 3 credit hours post M.S.): Students are required to complete a coherent sequence of graduate courses in Information Technology. The purpose of this requirement is to provide depth of understanding of Information Technology concepts, in particular, concepts that may be the focus of research activities.

CST 625 Computer Database Management

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

Qualifying Examination courses:
The Qualifying Examination will be based on first-year courses (equivalent to 18-20 credit hours), including Foundation Courses.

STEM Education

The STEM Education Ph.D. concentration course requirements (18 credit hours; 15 credit hours post M.S.) are:

STEM Education Foundation Courses (6 credit hours; 3 credit hours post M.S.)
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

Qualifying Examination courses:
The Qualifying Examination will be based on first-year courses (equivalent to 18-20 credit hours), including Foundation Courses.

Technology Management
The Technology Management Ph.D. concentration course requirements (18 credit hours; 15 credit hours post M.S.) are:

Technology Management Foundations (9 credit hours) The purpose of the Foundation requirements is to provide a framework for foundational concepts:

AET 701 Technology Management Principles
AET 810 Project Management Essentials
AET 820 Managing R&D Processes

Technology Management Expertise & Research Specialization (9 credit hours; 6 credit hours post M.S.):
Students are required to complete a coherent sequence of graduate courses in Technology Management. The purpose of this requirement is to provide depth of understanding of Technology Management concepts, in particular, concepts that may be the focus of research activities.

AET 700 Graduate Seminar
AET 702 Technology Management Strategies
AET 703 Technology Management Analytics
AET 704 Technology Management Research
AET 705 Design of Experiments
AET 710 Manufacturing Materials
AET 715 Tool Technology
AET 716 Glass Processing
AET 720 Industrial Economics
AET 721 Industrial Operational Management
AET 722 Six Sigma Advanced Topics
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 775 Decision Modeling and Analysis
AET 780 Reliability Testing and Analysis
AET 784 Internship
AET 830 Internet of Things Technology
AET 840 Industrial Fire Protection
AET 885 Special Topics

CM 679 Environmental Issues in Construction Management
CM 708 Construction Cost Estimating and Project Controls
CM 710 Advanced Construction Practices & Organization
CM 715 Productivity & Methods Improvement in Construction
CM 720 Contracts Administration
CM 762 International Construction Management
CM 764 Risk Management in Construction
CM 780 Trends in CM of International Projects
CM 786 Construction Trends & Analysis
LAND 781 Management in Construction
ECEN 885 Advanced Robotic Systems
INEN 833 Supply Chain System Engineering
INEN 861 Nano Micro and Bio Manufacturing

Qualifying Examination courses:
The Qualifying Examination will be based on first-year courses (equivalent to 18-20 credit hours), including Foundation Courses.

General
The general (i.e., no concentration specified) track is for students who are interested in pursuing an area that is not one of our defined PhD concentrations. The curriculum will therefore vary per student and will be designed through the Plan of Study process in collaboration with your primary advisor, graduate coordinator and AST program director.

Qualifying Examination courses:
The Qualifying Examination will be based on first-year courses (equivalent to 18-20 credit hours), including Foundation Courses.

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.

Please refer to the AST Student Handbook for full description of program guidelines, policies, requirements and expectations.