New AST Ph.D. Curriculum Guide Effective 2022-2023

Applied Science and Technology, Ph.D.
College of Science and Technology
Program Director: Jenora Waterman  Email: jdwaterm@ncat.edu  Phone: 336-285-2329

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):
  o AST 830 Foundations of Scientific Research
  o AST 831 Math and Computational Modeling (or other graduate analytical modeling course that builds upon a student’s previous background)
  o 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 credits post M.S.) within one of the following concentrations:
  o 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
Advanced Remote Sensing
Tropical Meteorology
Advanced Mesoscale Analysis
Special Topics
Introduction to Nano Energy
Advanced Nano Energy Systems
Special Topics in Renewable Energy Technology
Environmental Issues in Construction Management
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 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 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
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
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<tr>
<th>Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>TECH 730</td>
<td>Diversity Issues in Education and Industry</td>
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<tr>
<td>TECH 762</td>
<td>Evaluation of Technological Education Programs</td>
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<tr>
<td>TECH 763</td>
<td>Technology Education for Elementary Grades</td>
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<tr>
<td>TECH 765</td>
<td>Evaluation of Training in Industrial Settings</td>
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<td>TECH 772</td>
<td>Curriculum Development in Technology Education</td>
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<td>LEST 860</td>
<td>Qualitative Research</td>
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<tr>
<td>LEST 864</td>
<td>Ethnographic Methods in Social Science Research</td>
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<td>LEST 865</td>
<td>Mixed Methods Research</td>
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<td>ADED 708</td>
<td>Instructional Methods in Adult Education</td>
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<td>ADED 719</td>
<td>Assessment and Evaluation</td>
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<td>ADED 722</td>
<td>Diverse Perspectives in Adult Education</td>
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<td>ADED 776</td>
<td>Principles of College Teaching</td>
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<td>CUIN 724</td>
<td>Problems and Trends in Teaching Science</td>
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<td>CUIN 727</td>
<td>Workshop Method of Teaching Math</td>
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<td>CUIN 753</td>
<td>Teaching Engineering and Technology in Middle School</td>
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<td>CUIN 784</td>
<td>Current Research in Secondary Education</td>
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<td>AGED 703</td>
<td>Scientific Methods in Education Research I</td>
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<td>AGED 704</td>
<td>Foundations and Philosophy of Agricultural Education</td>
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<tr>
<td>AGED 711</td>
<td>Advanced Teaching &amp; Assessment Methodology</td>
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<tr>
<td>AGED 751</td>
<td>Agricultural Education Across the Curriculum</td>
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<td>AGED 752</td>
<td>Special Populations in Agricultural Education</td>
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**General**

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

**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.