New AST Ph.D. Curriculum Guide Effective 2021-2022

Applied Science and Technology, Ph.D.
College of Science and Technology
Program Director: Jenora Waterman  Email: jdwterm@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): 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
• 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
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
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>AET 770</td>
<td>Managing Total Quality Systems</td>
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<td>AET 772</td>
<td>Strategic Concepts in Quality</td>
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<td>AET 780</td>
<td>Reliability Testing and Analysis</td>
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<tr>
<td>AET 810</td>
<td>Project Management Essentials</td>
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<tr>
<td>AET 820</td>
<td>Managing R&amp;D Process</td>
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<tr>
<td>AET 830</td>
<td>Internet of Things Technology</td>
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<tr>
<td>AET 840</td>
<td>Industrial Fire Protection</td>
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<tr>
<td>AET 885</td>
<td>Special Topics</td>
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<tr>
<td>MSTM 701</td>
<td>Strategic Management of Technology and Innovation</td>
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<td>MSTM 702</td>
<td>Enterprise Resource Plan Systems</td>
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<td>MSTM 703</td>
<td>Statistics and Probability in Technology Management</td>
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<td>MSTM 704</td>
<td>Research Methods for Technology Management</td>
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<tr>
<td>MSTM 705</td>
<td>Advanced Applied Statistics and Probability</td>
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<tr>
<td>MSTM 779</td>
<td>Statistical Research in Technology Management</td>
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<td>LAND 781</td>
<td>Risk Management in Construction</td>
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<tr>
<td>CM 710</td>
<td>Advanced Construction Practices &amp; Organization</td>
</tr>
<tr>
<td>CM 715</td>
<td>Productivity &amp; Methods Improvement in Construction Management</td>
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<tr>
<td>CM 720</td>
<td>Construction Contracts Administration</td>
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<tr>
<td>CM 764</td>
<td>Risk Management in Construction</td>
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<tr>
<td>CM 780</td>
<td>Emerging Trends in CM of International Projects</td>
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<tr>
<td>CM 786</td>
<td>Construction Trends &amp; Analysis</td>
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<tr>
<td>TECH 708</td>
<td>Impacts of Technology</td>
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<tr>
<td>ECEN 885</td>
<td>Advanced Robotic Systems</td>
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<td>INEN 833</td>
<td>Supply Chain System Engineering</td>
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<td>INEN 861</td>
<td>Nano Micro and Bio Manufacturing</td>
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**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:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>AST 801</td>
<td>History and Philosophy of STEM Education</td>
</tr>
<tr>
<td>AST 802</td>
<td>Theories of Development and STEM Thinking</td>
</tr>
<tr>
<td>AST 803</td>
<td>STEM Education Methods</td>
</tr>
</tbody>
</table>

**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.

<table>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>AST 804</td>
<td>Cognitive Devices in STEM Learning Environments</td>
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**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.

<table>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>TECH 719</td>
<td>Technology Education: Design in Construction</td>
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<tr>
<td>TECH 720</td>
<td>Technology Education: Design in Manufacturing</td>
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<tr>
<td>TECH 722</td>
<td>Technology Education: Design in Transportation</td>
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<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>
</tr>
<tr>
<td>TECH 763</td>
<td>Technology Education for Elementary Grades</td>
</tr>
</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.