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

Applied Science and Technology, Ph.D.
College of Science and Technology

Program Director: Keith Schimmel    Email: schimmel@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:
  o Applied Chemistry
• 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
COMP 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
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.