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

Applied Science and Technology, Ph.D.

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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

- Applied Physics
- o Atmospheric, Environmental and Energy Science
- o Bioscience
- o Data Science and Analytics
- Information Technology
- o Technology Management
- 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
Bioscie	<u>nce</u>	
кю	615	Principles of Virology

BIOL	615	Principles of Virology
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- 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 ST	TEM Learning Environments
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- 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.