Delaware Department of Education

CTE & STEM Office

401 Federal Street, Suite 256

Dover, DE 19901

Phone: 302.735.4015

 \*\*Submit application via the CTE Portal on IMS\*\*

**DELAWARE CTE PROGRAM OF STUDY APPLICATION**

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| LOCAL EDUCATION AGENCY INFORMATION  |
| **Local Education Agency (LEA):** |
| **School(s) where the Program of Study will be Located:** | **Program of Study Start Date:**       |
| **LEA CTE Coordinator Name:** **Phone:** **E-Mail Address:**  |
| **Career Cluster Title:**Architecture & Construction | **Career Pathway Title:**Design/Pre-Construction | **Program of Study Title:**Geospatial Science & Technology (GST) |
| **CTE Program of Study Course Titles & Sequence:**1. Foundations of Technology (FOT)
2. Introduction to Geospatial Science and Technology (IGST)
3. Advanced Geospatial Science and Technology (AGST)
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| **CTE Program of Study Request:**[ ]  State-model CTE Program of Study[x]  Local CTE Program of Study |
| ASSURANCES & SIGNATURES |
| CTE Program of Study approval and funding is contingent upon the following assurances:1. The LEA will comply with Delaware Administrative Code, 14 DE Admin. 525, Requirements for Career and Technical Education Programs and the Delaware State Plan for the Strengthening Career and Technical Education for the 21st Century Act (known as Perkins V);
2. The LEA will submit CTE program data as required by the Delaware Department of Education;
3. All teachers are certified in the appropriate CTE area and participate in program specific professional learning;
4. The LEA will convene and engage a program advisory committee for the purposes of program development, implementation, and continuous improvement;
5. All students have equal access to the program of study as well as early career/early college options;
6. Career and Technical Student Organizations are integral components of the program of study;
7. The LEA will maintain safe facilities and equipment aligned with the program of study goals; and
8. A process for continuous improvement has been established, which includes a model of evaluation and program improvement.
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| LEA CTE Coordinator Signature: Date: |
| LEA Chief School Officer Signature: Date: |
| PROGRAM ADVISORY COMMITTEE MEMBER INFORMATION |
| Complete the list of program advisory committee members. Program of study representatives should include, but are not limited to: CTE and academic teachers, CTE/curriculum district coordinators, school counselors, business and industry representatives, labor representatives, and post-secondary partners. Community stakeholders including parents and students can also be considered. *Attach additional information if applicable*. |
| Name: Title:Kymberlie J. Kelly, GISP Instructor |
| Affiliation:Delaware Technical Community College |
| Address:400 Stanton-Christiana Rd., Newark, DE 19713 |
| Phone: E-Mail:302-454-3186 kym.kelly@dtcc.edu |
| Area of Expertise:Geographic Information Systems, Land Surveying, Civil Engineering Technology, Visual Communication |
| Representing: [ ]  Business/Industry[ ]  Secondary Education[x]  Post-Secondary Education[ ]  Community/Other |
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| Name: Title:Dr. Tracy DeLiberty Associate Professor |
| Affiliation:University of Delaware |
| Address:Pearson Hall, Room 213, Department of Geography, University of Delaware, Newark, DE 19716 |
| Phone: E-Mail:302-831-4084 tracyd@udel.edu |
| Area of Expertise:Geographic Information Systems, Remote Sensing, Climatology |
| Representing: [ ]  Business/Industry[ ]  Secondary Education[x]  Post-Secondary Education[ ]  Community/Other |

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| Name: Title:Mary Schorse Program Director |
| Affiliation:Delaware Center for Geographic Education |
| Address:216 Pearson Hall, University of Delaware, Newark, DE 19716 |
| Phone: E-Mail:302-593-3049 schorse@udel.edu |
| Area of Expertise:Geography Education, Sustainability, Natural Resource Policy |
| Representing: [ ]  Business/Industry[ ]  Secondary Education[ ]  Post-Secondary Education[x]  Community/Other |
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| Name: Title:Miriam Pomilio Principal Planner - GIS Coordination |
| Affiliation:Delaware Office of State Planning Coordination |
| Address:122 Martin Luther King Jr. Blvd, Dover, DE 19901 |
| Phone: E-Mail:302-739-3090 miriam.pomilio@state.de.us |
| Area of Expertise:General GIS knowledge and Delaware First Map |
| Representing: [x]  Business/Industry[ ]  Secondary Education[ ]  Post-Secondary Education[ ]  Community/Other |
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| Name: Title:Jason McCluskey Maintenance Engineer |
| Affiliation:DelDOT Maintenance & Operations |
| Address:23697 DuPont Blvd., Georgetown, DE 19947 |
| Phone: E-Mail:302-387-3935 jason.mccluskey@state.de.us |
| Area of Expertise:Project management; structural and drainage design |
| Representing: [x]  Business/Industry[ ]  Secondary Education[ ]  Post-Secondary Education[ ]  Community/Other |
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| Name: Title:Christopher Hoinowski Party Chief |
| Affiliation:Axis Geospatial |
| Address:40 McCullough Dr., New Castle, DE 19720 |
| Phone: E-Mail:302-256-8184 cahoinowski@gmail.com |
| Area of Expertise:LiDAR, GPS control, laser scanning, topographical, boundary, alta and construction survey |
| Representing: [x]  Business/Industry[ ]  Secondary Education[ ]  Post-Secondary Education[ ]  Community/Other |
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| Name: Title:Jay W. Hodny, Ph.D. GIS Technician |
| Affiliation:City of Newark, DE |
| Address:30 Argyle Road, Newark, DE 19713 |
| Phone: E-Mail:302-757-9283 hodny@udel.edu |
| Area of Expertise:Project management, computer mapping, GIS, climate and water resources |
| Representing: [x]  Business/Industry[ ]  Secondary Education[ ]  Post-Secondary Education[ ]  Community/Other |
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| Name: Title:John Callahan Climate Scientist |
| Affiliation:University of Delaware |
| Address:257 Academy St., Newark, DE 19716 |
| Phone: E-Mail:302-831-3584 john.callahan@udel.edu |
| Area of Expertise:Climate and weather, natural hazards, coastal storms, climate change and sea level rise, geospatial analysis, GIS and Remote Sensing, lidar, statistics |
| Representing: [ ]  Business/Industry[ ]  Secondary Education[x]  Post-Secondary Education[ ]  Community/Other |
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| Name: Title:Ian R Tangert Training Specialist |
| Affiliation:      |
| Address:535 West Frederick Street., Lancaster, PA 17603 |
| Phone: E-Mail:717-333-1721 itangert@gmail.com |
| Area of Expertise:GIS database management and analysis, and instruction |
| Representing: [x]  Business/Industry[ ]  Secondary Education[ ]  Post-Secondary Education[ ]  Community/Other |
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| Name: Title:Ceil Hoopes    Academic Counselor    |
| Affiliation:Delaware Technical Community College |
| Address:400 Stanton-Christiana Rd., Newark, DE 19713 |
| Phone: E-Mail:302-453-3790 choopes@dtcc.edu |
| Area of Expertise:Delaware Tech Admissions |
| Representing: [ ]  Business/Industry[ ]  Secondary Education[x]  Post-Secondary Education[ ]  Community/Other |

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| ACADEMIC AND TECHNICAL SKILL STANDARDS |
| List the academic, technical, and workplace skills and knowledge used to develop the program of study. |
| **Title and source of academic standards:** [Common Core State Standards (CCSS)](http://www.corestandards.org/) The Common Core State Standards (CCSS) are national standards that set clear college- and career-ready expectations for kindergarten through 12th grade in English language arts/literacy and Mathematics. These learning goals outline what a student should know and be able to do at the end of each grade. The standards were created to ensure that all students graduate from high school with the skills and knowledge necessary to succeed in college, career, and life, regardless of where they live. The standards define the knowledge and skills students should gain throughout their K-12 education in order to graduate high school prepared to succeed in entry-level careers, introductory academic college courses, and workforce training programs. The standards were developed by the nation's governors and education commissioners, through their representative organizations, the National Governors Association Center for Best Practices (NGA) and the Council of Chief State School Officers (CCSSO). Teachers, parents, school administrators, and experts from across the country provided input into the development of the standards. The implementation of the Common Core, including how the standards are taught, the curriculum developed, and the materials used to support teachers as they help students reach the standards, is led entirely at the state and local levels. For more information on CCSS, please visit the link above. [Delaware State Standards for Social Studies](https://www.doe.k12.de.us/Page/2548) (Geography) and the Geospatial Science & Technology (GST) program of study connect through contemporary and practical applications that drawing from problems encountered and solutions reached in local communities. Social Studies prepares students to become informed and active citizens who accept their responsibilities, understand their rights, and participate actively in society and government.  Effective citizens must be able to research issues, form reasoned opinions, support their positions, and engage in the political process. Geography standards, in particular, expect students to apply a geographical perspective to life situations. Geography studies the relationships of people, places, and environments from the perspective of where they occur, why they are there, and what meaning those locations have for society. Geospatial technologies play a critical role in synthesizing large quantities of data for geographic analysis and for developing a better appreciation of the nature of their world and their place in it. Students apply the knowledge, skills and perspectives of geography. They research problems, analyze data, and suggest solutions using a GIS-based approach.  For more information on the Delaware State Standards for Social Studies, please visit the link above.[Next Generation Science Standards (NGSS)](http://www.nextgenscience.org/)The Next Generation Science Standards (NGSS) are national standards for science that lay out the disciplinary core ideas, science and engineering practices, as well as crosscutting concepts that students should master in preparation for college and careers. The standards were developed through a state-led effort that was managed by Achieve. The development of the NGSS involved the National Research Council (NRC), the National Science Teachers Association (NSTA), and the American Association for the Advancement of Science (AAAS), and other critical partners such as K–12 teachers, state science and policy staff, higher education faculty, scientists, engineers, cognitive scientists, and business leaders. For more information on the NGSS, please visit the link above.  |
| **Title and source of technical skill standards:** [ArcGIS Desktop Entry Level Certification](https://www.esri.com/training/certification-find-exam/desktop/)The ArcGIS Desktop Entry exam tests the candidate's experience applying ArcGIS concepts and processes to workflows. Qualified candidates should demonstrate comprehension of basic ArcGIS concepts, including ArcGIS platform awareness at an entry level. Candidates should perform entry-level mapping and visualization tasks, editing, and file geodatabase management tasks. Qualified candidates should have less than two-years of applied experience, and should be proficient in best practices and uses of Esri's ArcGIS technologies.  |
| **Title and source of workplace or other skill standards, as applicable:**[Common Career Technical Core (CCTC)](http://www.careertech.org/CCTC)The Common Career Technical Core (CCTC) are national standards for Career & Technical Education (CTE) that help to inform the establishment of state standards and/or programs of study. The CCTC were developed by educators, school administrators, representatives from business and industry, faculty from higher education, as well as workforce and labor markets economists.  The CCTC includes a set of standards for each of the sixteen (16) Career Clusters and the corresponding Career Pathways that help to define what students should know and be able to do after completing instruction in a program of study. The CCTC standards for Architecture & Construction and the STEM Career Cluster are reflected inside the courses for the Architectural & Construction Management (ACM) program of study. The program has students apply the CCTC Architecture & Construction and STEM standards. For more information on the CCTC, please visit the link above.[Career Ready Practices (CRP)](http://www.careertech.org/career-ready-practices)The Career Ready Practices (CRP) are a component of the CCTC framework and includes twelve (12) statements that address the knowledge, skills, and dispositions that are important to becoming career ready. The CRP describes the career-ready skills that educators should seek to develop in their students. These practices are not exclusive to a Career Pathway, program of study, discipline, or level of education and should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a career pathway. The CRP statements are embedded throughout the Architectural & Construction Management (ACM) program of study to ensure students display the appropriate soft skills and workplace requirements necessary to be successful in a career. For more information on the CRP, please visit the link above. [Geospatial Technology Competency Model](https://www.careeronestop.org/competencymodel/competency-models/geospatial-technology.aspx) The Geospatial Technology Competency Model framework was developed through a collaborative effort involving the Employment and Training Administration (ETA), the GeoTech Center, and industry experts. The model covers the knowledge, skills, and abilities from which workers across the industry can benefit, regardless of the sector in which they operate. These competencies are considered cross-cutting, as they allow a worker to move easily across industry sub-sectors. The program prepares students to be competent in Tier 4.1 -Crosscutting Geospatial Abilities and Knowledge – Industry-Wide Technical Competencies. For more information on the Geospatial Technology Competency Model please visit the link above. |
| EARLY CAREER AND EARLY COLLEGE OPPORTUNITIES |
| Identify CTE program of study early career opportunities, industry-recognized certifications and licenses, options for early college credit, two- and four-year degree and certification program alignment, and the technical skill attainment measures for the program of study. *Attach articulation/dual enrollment agreement(s)*. |
| **Describe early career opportunities (i.e. work-based learning experiences and industry-mentored projects):** The Geospatial Science and Technology (GST) program is a three (3) credit program of study delivered in partnership with Delaware Technical Community College (DTCC) and University of Delaware (UD) that engages students in open-ended problem solving where students will use industry-standard software, and apply math and science to solve geospatial problems. Students will work both individually and in teams to learn the fundamental concepts that underline GIS technology and geographic data. Student will explore a broad range of geospatial topics including data collection & management, spatial analysis, and mapping using geographic information systems (GIS). Students will develop skills in problem solving, research and design while learning strategies for design process and workflow documentation, collaboration, and presentation. The CTE program consists of three courses: Foundations of Technology (FOT), Introduction to Geospatial Science and Technology, and the capstone course of Advanced Geospatial Science and Technology. Work-based learning experiences and industry-mentored projects will be investigated by the Local Education Agency (LEA) and Program Advisory Committee to further identify opportunities to engage the community.  |
| **List industry-recognized certifications and/or licenses, as appropriate (include the partner organization and credential):** [Engineering byDesign (EbD)](https://www.iteea.org/EbD.aspx) provides industry-based pre- and post-assessments known as course level assessments for participating network schools. EbD will report valid and reliable scores on overall student performance for the Foundations Of Technology (FOT) course. The assessment gives students an objective evaluation of their achievement and stakeholders the opportunity to obtain and use data to make informed decisions. [ArcGIS Desktop Entry Level Certification](http://www.pearsonvue.com/esri/) is a task-based assessment from ESRI that leads to industry recognized credential that validates mastery of user based technical skills and that are reflective of both real-world academic and industry requirements. |

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| **Describe early college credit options (i.e. advanced placement, dual enrollment, transcripted and/or articulated credit, credit by exam, pre-apprenticeship, other) and options for two- and four-year degree and/or certification program alignment (attach articulation/dual enrollment agreement). The partner organization and hours of credit earned should be included, as applicable:**Students who successfully complete the Geospatial Science and Technology (GST) program of study will receive 7 articulated credits at Delaware Technical Community College (DTCC) or 6 articulated credits at the University of Delaware (UD). These credits may be applied to the following programs of study offered by DTCC or UD:***Delaware Technical Community College (DTCC):*****Environmental Engineering Technology OR; Geographic Information System Technology (AAS): 7 articulated credits*** GIS101 - Introduction to GIS (3 articulated credits)
* GIS110 - GIS110 (4 articulated credits)

**Civil Engineering Technology; OR; Surveying and Geomatics Engineering Technology (AAS): 3 articulated credits*** GIS101 - Introduction to GIS (3 articulated credits)

***University of Delaware (UD):*****Geography with Geospatial Techniques Concentration (BA); Geological Science (BS); OR GIScience and Environmental Data Analytics (BS): 6 articulated credits*** GEO372 - Geographic Information Systems (3 articulated credits)
* GEO471 - Advanced Geographic Information Systems GIS (3 articulated credits)

**Energy and Environmental Policy (BS); Environmental Engineering (BS); Environmental Science (BS); Environmental Studies (BA); OR Landscape Architecture (BS): 3 articulated credits*** GEO372 - Geographic Information Systems (3 articulated credits)
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| **List technical skill attainment measures for the program of study (i.e. industry recognized certification or license, advanced placement, dual enrollment, transcripted and/or articulated credit, dual enrollment, credit by exam):**[x]  Certification/credentialing exam (specify): ArcGIS Desktop Entry Level Certification[ ]  Licensing exam (specify):      [ ]  Nationally recognized exam (specify):      [x]  Advanced standing (specify): Delaware Technical Community College articulated credit: GIS101 – Introduction to GIS (3 credits)GIS 110 – Spatial Data Analysis & Modeling (4 credits)University of Delaware articulated credit: GEOG372 – Geographic Information Systems (3 credits)GEOG471 – Advanced GIS (3 credits)[ ]  Other (specify):       |
| POS OVERVIEW, COURSE DESCRIPTIONS, END-OF-COURSE, AND PROGRAM ASSESSMENTS |
| Provide a CTE program of study overview that broadly describes the program and student expectations. Identify end-of-program assessment(s) and opportunities for students to participate in early college and early career experiences. List each course title in the CTE program of study. Provide an overview of each course and define what students should know and be able to demonstrate upon completion of each level. Identify appropriate end-of-course assessment(s).  |
| **CTE Program of Study Overview:** The Geospatial Science and Technology (GST) program is a three (3) credit program of study that engages students in the world of geospatial science and technology through coursework focusing on geographic information systems (GIS) to use information from geodetic surveys and remote-sensing systems, including aerial cameras and satellites for urban and regional planning, security, land-use planning, business marketing, and public safety for emergency responders. The GST program of study will lead to students earning ArcGIS Desktop Entry Level Certification, advanced standing for up to 7 credits at Delaware Technical Community College (DTCC), advanced standing for up to 6 credits at University of Delaware, and advanced skills in geographic information systems (GIS). The program prepares students for careers such as Cartographers; Civil Engineers, Geographers; Photogrammetrists; Surveyors; and Surveying and Mapping Technicians.The GST program of study will lead to students earning ArcGIS Desktop Entry Level Certification, advanced standing for up to 7 credits at Delaware Technical Community College (DTCC), advanced standing for up to 6 credits at University of Delaware, and advanced skills in geographic information systems (GIS).* **Foundations of Technology (FOT)** prepares students with the ability to innovate, improvise, and invent solutions to engineering problems. Students explore how technological innovations result when ideas, knowledge, and skills are shared within a technological cluster and amongst other fields of study. In this course, students develop foundational skills in engineering design and documentation as a formal process to transform ideas into products or systems.
* **Introduction to Geospatial Science and Technology** is an articulated course (GIS 101 – Introduction to GIS at DTCC or GEOG 372 – Introduction to GIS at UD) that introduces the fundamental geographic concepts and principles necessary to effectively use a geographic information system (GIS) to solve geographic problems. Hands-on training is provided in the use of professional GIS software in the context of collecting, managing, processing, analysis and presenting geographic data. Topics include data structures and basic functions, methods of data capture and sources of data, and the nature and characteristics of spatial data and objects.
* **Advanced Geospatial Science and Technology** is an articulated course (GIS 110 – Spatial Data Analysis & Modeling at DTCC or GEOG 471 – Advanced GIS at UD) that expands on the principles and concepts covered in Introduction to Geospatial Science and Technology to effectively use a geographic information system (GIS) to solve geographic problems. This course focuses on problem solving and decision making using geospatial analysis techniques applicable to a range of disciplines. It focuses on both vector and raster data analysis and applicable workflows and includes introductory scripting to improve workflow. Topics include advanced data models, preprocessing, spatial analysis and modeling, uncertainty, and visualization methods for exploring geographic data and analysis results.
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| **End-of-Program Assessment(s):**[x]  Certification/credentialing exam (specify): ArcGIS Desktop Entry Level Certification[ ]  Licensing exam (specify):      [x]  Nationally recognized exam (specify): Engineering by Design (EbD)– Foundations of Technology (FOT)[x]  Other (specify): DTCC/UD Portfolio requirement, which serves as evidence for the purpose of evaluating technical learning progress, and academic achievement. |
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| **Course title:**Foundations of Technology (FOT) |
| **Course description (include prerequisites):**Foundations of Technology (FOT) prepares students with the ability to innovate, improvise, and invent solutions to engineering problems. Students explore how technological innovations result when ideas, knowledge, and skills are shared within a technological cluster and amongst other fields of study. In this course, students develop foundational skills in engineering design and documentation as a formal process to transform ideas into products or systems. Pre-requisite or concurrent enrollment requirement: Algebra I |
| **Course knowledge and skills (what students will know and be able to do):** By the end of this course, students will:1. Analyze technological innovations and inventions to: create mathematical representations that illustrate the rapidly increasing rate of technological development and diffusion; develop an invention or innovation as a result of goal-oriented research and design; debate an example of a technology in which the development was driven by the profit motive; and discuss how technology transfer occurs and how it can be applied toward existing innovations for a different function.
2. Research and discuss the patenting process in order to: interpret how the patenting process is used to protect technological ideas and develop examples of an evolutionary technology that has resulted from a series of refinements to a basic invention.
3. Apply advertising, economic analysis, and production considerations to: determine how advertising, the strength of the economy, the goals of the company, and market analysis contribute to influence design criteria and constraints; develop success versus failure rubrics for products; and determine impacts of technologies other than those intended by the design.
4. Illustrate the research and development process to: construct problem-solving approaches; prepare proposals for devices and systems to meet the needs of the marketplace; and present research and development criteria in the development of a new invention or innovations that meets a market need.
5. Analyze precision and accuracy of measurement to: construct and modify components of a product based upon design constraints; discuss systems that are embedded within larger technological, social, and environmental systems; debate how technological progress is advanced through the application of science and mathematics; and apply scientific and mathematic analysis techniques to evaluate a product.
6. Analyze the application of a technology to: determine trade-offs between positive and negative impacts and predict positive and negative effects of a technology on the environment.
7. Apply the steps of the engineering design process to: define a problem to be solved that includes brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing, and communicating results and draw conclusions about a situation being modeled based on data.
8. Analyze and create three-dimensional objects in order to: define objects and spaces from different perspectives; demonstrate how to test a design in order to redefine and improve the design; and select design requirements to redefine and improve a product within the design criteria.
9. Determine principles used in a current design to: analyze data on the effectiveness of the design principles used; propose a redesign using the design process; apply mathematical modeling aids to simulate how a proposed system might behave; and apply scientific laws, engineering principles, properties of materials, and construction techniques to design engineered solutions to problems.
10. Use symbolic algebra to: represent and explain mathematical relationships; apply geometric ideas to solve problems; apply mathematics to visualize engineering design solutions; draw and construct representations of two- and three-dimensional geometric objects using a variety of tools; collect data and information and use computers and calculators to organize, process, and present the information; and make decisions about units and scales that are appropriate for problem situations involving measurement.
11. Communicate technological solutions through: observations, processes, and results of the design process through a final solution; the use of appropriate verbal, graphic, quantitative, virtual, and written means to communicate a solution; and presentations to a target audience using appropriate oral and written techniques.
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| **End-of-Course Assessment(s):**[ ]  Teacher designed assessment[ ]  LEA designed assessment[ ]  Certification/credentialing exam (specify):      [ ]  Licensing exam (specify):      [x]  Nationally recognized exam (specify):  Engineering byDesign (EbD) Course Level Assessment – Foundations of Technology (FOT)[ ]  Other (specify):       |
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| **Course title:**Introduction to Geospatial Science and Technology |
| **Course description (include prerequisites):****Introduction to Geospatial Science and Technology** is an articulated course (GIS 101 – Introduction to GIS at DTCC or GEOG 372 – Introduction to GIS at UD) that introduces the fundamental geographic concepts and principles necessary to effectively use a geographic information system (GIS) to solve geographic problems. Hands-on training is provided in the use of professional GIS software in the context of collecting, managing, processing, analysis and presenting geographic data. Topics include data structures and basic functions, methods of data capture and sources of data, and the nature and characteristics of spatial data and objects.Prerequisite: Foundations of Technology |
| **Course knowledge and skills (what students will know and be able to do):** By the end of this course`, students will:1. Define geospatial science and technology and identify spatial data and the major components of a Geographic Information System (GIS) to: recognize and identify spatial data; identify components of a GIS and associated software; discuss how spatial data is used in GIS applications; define vector data models, raster data models, and spatial data infrastructure framework; identify common GIS operations.
2. Demonstrate georeferencing of spatial data, and explain the geographic variables involved in order to: define vertical datum and horizontal datum, identify and differentiate global and planar coordinate systems; define map projection; identify and discuss common map projections and their distortion properties; distinguish between different coordinate systems and their application with GIS; import data into a specific coordinate system; project geographic data from a geographic to a planer coordinate system; and demonstrate converting from one coordinate system to another.
3. Employ vector data structure to create geographic data including: describe the elements of vector data; identify the importance of topology in GIS mapping and the rules that must be applied; describe object-based data models and the classes of relationships; produce and edit vector data; and digitize vector data.
4. Identify and describe raster data models including: describe the elements of raster data; identify and discuss the types of raster data; and describe raster data structure.
5. Employ fundamentals of data management and acquisition of new data including: how geographic data is stored in a database management system, identify and describe existing data sources, including but not limited to GPS, remote sensing, aerial photography, and Master Address File/Topologically Integrated Geographic Encoding and Referencing (MAF/TIGER) system or database; identify where errors originate from in mapping and data collection, including accuracy and precision of data; explain metadata; describe control points in the context of land surveying; import existing data from various sources and file formats; collect data using GPS enabled equipment; and georectify a scanned map.
6. Illustrate GIS data input and manipulation including: identify the types of attribute data; identify attribute data entry methods and verification; describe how to classify and manipulate attribute data; classify, manipulate, and create attribute data; produce a geodatabase and feature dataset; and convert vector data to raster data.
7. Employ meaningful data display in the creation of maps including: identify basic fundamentals of cartographic design principles, including symbology, color, classifications, and standard map design layouts; describe the various types of maps; employ cartographic design principles to produce a meaningful map.
8. Employ data exploration and manipulation techniques in a GIS to: identify and employ various query types and associated properties; distinguish between raster- and vector-based data applications; use geoprocessing applications such as clip, buffer, and overlay; measure distances between points and lines; and employ operations common to raster- and vector-based data analysis.
9. Demonstrate professional and ethical conduct as expected in industry including: identify the need for self-discipline and time management in technical industries; demonstrate the ability to communicate and function effectively as a member of a team; apply professional and ethical responsibilities under the [GIS Certification Institute’s Code of Ethics and Rules of Conduct](https://www.gisci.org/Ethics/CodeofEthics.aspx).
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| **End-of-Course Assessment(s):**[ ]  Teacher designed assessment[ ]  LEA designed assessment[ ]  Certification/credentialing exam (specify):      [ ]  Licensing exam (specify):      [ ]  Nationally recognized exam (specify):      [x]  Other (specify): DTCC/UD End of Course assessment for GIS 101 – Introduction to GIS and GEOG 372 – Introduction to GIS |

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| **Course title:**Advanced Geospatial Science and Technology |
| **Course description (include prerequisites):****Advanced Geospatial Science and Technology** is an articulated course (GIS 110 – Spatial Data Analysis & Modeling at DTCC or GEOG 471 – Advanced GIS at UD) that expands on the principles and concepts covered in Introduction to Geospatial Science and Technology to effectively use a geographic information system (GIS) to solve geographic problems. This course focuses on problem solving and decision making using geospatial analysis techniques applicable to a range of disciplines. It focuses on both vector and raster data analysis and applicable workflows and includes introductory scripting to improve workflow. Topics include advanced data models, preprocessing, spatial analysis and modeling, uncertainty, and visualization methods for exploring geographic data and analysis results.Prerequisite: Introduction to Geospatial Science and Technology |
| **Course knowledge and skills (what students will know and be able to do):** By the end of this course, students will:1. Employ an approach appropriate to solving a geospatial problem to: identify the difference between spatial data analysis and statistical data analysis; identify the characteristics and the importance of statistical relationships in spatial data; define the elements in a geospatial problem; identify techniques for exploratory spatial data analysis; identify criteria for selection of geoprocessing operations; describe the basic elements of geoprocessing models; discuss how scripting can improve workflow; distinguish data models from process models; employ application criteria for selection of geoprocessing operations; produce a workflow with outlined steps, procedures, and data necessary to solve a geospatial problem; and create geoprocessing models using a graphical scripting tool to build a geoprocessing workflow.
2. Prepare and organize data for use in analysis to: identify vector and raster data and their grouping as spatial objects and spatial fields; identify framework layers and be able to locate the framework data, identify and maintain principal metadata standards; discuss object models and topology using geodatabases; discuss common problems in the statistical analysis of geographic information, including data integrity, uncertainty, the effects of scale, autocorrelation, the modifiable areal unit problem, and edge effects; and produce new information from existing data through geoprocessing and spatial data model operations.
3. Analyze vector data including: describe the applications and methods for overlay and buffering; discuss pattern analysis; employ a buffering and overlay; apply measuring tools to determine distances between points and lines; compute general and local statistics; demonstrate the use of networks in data modeling and analysis; produce point pattern analysis; employ interpolation methods, and create contours; and utilize operations common to vector data analysis.
4. Analyze raster data including: identify applications and different operations for raster data analysis; describe neighborhood and zonal operations; describe physical and distance measure operations; describe raster data management and extraction; compare and contrast raster-based and vector-based analysis; utilize operations common to raster data analysis; produce surface visualization and analysis; apply Boolean map overlay; and apply physical and distance measure operations.
5. Illustrate results of analysis using appropriate terminology and visualizations including: identify proper symbology, color, and classification of map elements; identify methods for mapping different spatial objects (point, line, area, surface) and their attribute type (nominal, ordinal, interval, ratio) such as dot, chloropleth, graduated symbol, pie chart, flow map, or isarithmic maps discuss options in map presentation media and methods; identify an appropriate color design for mapping (general arrangement of hue and lightness) for nominal, sequential, and diverging data; apply the concepts of visual hierarchy and color theory to create a visually appealing map; demonstrate the use of map labeling variables (type size, weight, and font) to label map features effectively; employ cartographic design principles, such as proper map projections, to produce a meaningful map; and appraise the cartographic design principles, such as design, layout, and symbology of a peer’s map.
6. Demonstrate professional and ethical conduct as expected in industry including: identify the need for self-discipline and time management in technical industries; demonstrate the ability to communicate and function effectively as a member of a team; apply professional and ethical responsibilities under the [GIS Certification Institute’s Code of Ethics and Rules of Conduct](https://www.gisci.org/Ethics/CodeofEthics.aspx).
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| **End-of-Course Assessment(s):**[ ]  Teacher designed assessment[ ]  LEA designed assessment[x]  Certification/credentialing exam (specify): ArcGIS Desktop Entry Level Certification[ ]  Licensing exam (specify):      [ ]  Nationally recognized exam (specify):      [x]  Other (specify): DTCC/UD End of Course assessment for GIS 110 – Spatial Data Analysis & Modeling and GEOG 471 – Advanced GIS DTCC/UD Portfolio requirement which serves as evidence for the purpose of evaluating technical learning progress, and academic achievement. |

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| PROGRAM OF STUDY CURRICULUM |
| Identify the method of technical and academic curriculum development (adopted, adapted, or developed in accordance with guidance from the program advisory committee).  |
| **POS technical and academic curriculum will be:**[x]  Adopted (specify source): Foundations of Technology (FOT)[x]  Adapted (specify source):  Delaware Technical Community College articulated credit: GIS101 – Introduction to GIS (3 credits)GIS 110 – Spatial Data Analysis & Modeling (4 credits)University of Delaware articulated credit: GEOG372 – Geographic Information Systems (3 credits)GEOG471 – Advanced GIS (3 credits)[ ]  Developed locally (describe):      [ ]  Other (specify):       |
| TEACHER CERTIFICATION |
| Provide valid teacher certification(s), candidate experience, pre-requisite and requisite licensure or certification requirement(s) for POS teachers. |
| **POS teacher requirements include:**[x]  Teacher certification(s) (list): Agriculture Education; Geography Education; Technology Education; or Skilled and Technical Sciences (STS) cartographer; civil engineer; geographer; photogrammetrist; or surveyor.[x]  Candidate experience (describe): Candidate must have experience with data structures, methods of data capture, and the nature and characteristics of spatial data. Candidate may have experience in cartography, civil engineering, surveying, or geographic information systems (GIS) to use information from land surveys and remote-sensing systems, including aerial cameras and satellites. Some may also use light-imaging detection and ranging (LIDAR) technology to develop online and mobile maps aerial surveys for urban and regional planning, security, and public safety for emergency responders. GIS maps are used to provide support for decisions involving environmental studies, geology, engineering, land-use planning, and business marketing. may have certification as a Certified GIS Professional (GISP) through the GIS Certification Institute: For more information, please see the Bureau of Labor Statistics: Cartographers; Civil Engineers, Geographers; Photogrammetrists; Surveying and Mapping Technicians.[ ]  Pre-requisite professional licensure or certification requirement(s) (list):      [ ]  Requisite professional licensure or certification requirement(s) (list):      [ ]  Professional Licensure or Certification Credit Equivalency (list):      [x]  Other (describe): TBD in partnership with DTCC and UD- See GST Sample Budget for teacher professional development detail. |

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| VALUE-ADDED OPPORTUNITIES |
| List extended early career and college credit opportunities available during the student’s senior year. Document transition services, cooperative learning experiences, additional dual enrollment, or other.  |
| **Opportunities for extended and accelerated learning include:**[ ]  Cooperative education (describe):      [ ]  Structured internship (describe):      [ ]  Dual enrollment (list):      [ ]  Advanced Placement (list):      [ ]  Transition services (describe):      [ ]  Other (describe):       |

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| CAREER AND TECHNICAL STUDENT ORGANIZATIONS |
| Indicate the Career and Technical Student Organization (CTSO) affiliation by checking the appropriate box. |
| [ ]  BPA [ ]  FFA[ ]  DECA [ ]  HOSA[ ]  FCCLA [ ]  SkillsUSA[ ]  Educators Rising [x]  TSA |

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| PROGRAM OF STUDY MATRIX |
| Complete the program of study matrix to demonstrate the alignment of academic and technical courses, culminating early career and/or early college experiences. Identify appropriate certification and licensure options, opportunities for obtaining early college credit (courses with articulated or dual enrollment credit agreements should be appropriately designated within the matrix), the post-secondary program sequence, and potential career options. *Attach the Program of Study Matrix*. |
| Access the [Program of Study Matrix](http://www.doe.k12.de.us/domain/384).  |

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| DEPARTMENT OF EDUCATION PROGRAM OF STUDY APPROVAL |
| The following section will be completed by staff from the Delaware Department of Education, CTE & STEM Office and reported to the LEA as part of the CTE program of study approval process. |
| **Date Delaware CTE Program of Study Application Received:**      |
| **Local Education Agency (LEA):**     **School(s):**      | **Program of Study Start Date:**      |
| **LEA CTE Coordinator Name:** **Phone:** **E-Mail Address:**                    |
| **Career Cluster & Code:**Architecture/Construction / 2 | **Career Pathway & Code:**Design/Pre-construction / 2.01 | **Program of Study Title & Code:**Geospatial Science and Technology / 2.01606 |
| **CTE Program of Study Course Titles, Course Codes, and Funding Levels:**1. Course Name/Course Code/Funding Level: Foundations of Technology / 2.01606011 / 2 2. Course Name/Course Code/Funding Level: Intro to Geospatial Sci and Tech / 2.016060222 / 3 3. Course Name/Course Code/Funding Level: Advan Geospatial Sci and Tech / 2.01606011 / 3 |
| **CTE Concentrator/Completer Course Titles:**Concentrator Course: Introduction to Geospatial Science and TechnologyCompleter Course: Advanced Geospatial Science and Technology |
| **CTE Program of Study Request:**[x]  State-model CTE Program of Study[ ]  Local CTE Program of Study |
| **CTE Program of Study Attachments:**[x]  Labor Market Information (LMI) Review;[x]  Articulation/Dual Enrollment Agreement(s); and[x]  Program of Study Matrix. |
| DDOE CTE & STEM Director Signature: Date: |
| DDOE Chief Academic Officer Signature: Date: |