Drafting and Design Cluster: Geographical Information Systems - (Hydrography Technology)

Mississippi Curriculum Framework

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Division of Workforce, Career, and Technical Education 3825 Ridgewood Road
Jackson, MS 39211
Phone: 601-432-6155
Email: curriculum@mccb.edu

Faculty Writing Team Members

William (Brad) Frazier , Electronics Instructor, Pearl River Community College
Jarib Castillo-Salcedo, Automation & Controls Instructor, Pearl River Community College
Vic Cerniglia, Electronics Instructor, Pearl River Community College
Jason Walters, Automation & Controls Instructor, Pearl River Community College

Administrator Writing Team Members

Dr. Jennifer Seal, VP for Planning & Institutional Research, Pearl River Community College
Dr. Martha Smith, Senior VP for Instruction/Provost, Pearl River Community College
Dr. Amy Townsend, Dean of Career & Technical Programs, Pearl River Community College

Business and Industry Contributing Team Members

Joel Lawhead, Vice President, NVision Solutions, Inc.*
Natalie Guess,*
David Brannon, NOARC*
Damon Wolfe, ECHO81, President
Josh Dougan, The Hydrographic Society of America, President

***Denotes an industry member who attended the writing team meeting.**

Office of Curriculum and Instruction Team Members

Scott Kolle, Ph.D., Director of Curriculum, Mississippi Community College Board
LaToya Sterling, Ph.D., Curriculum Specialist, Mississippi Community College Board

The Office of Curriculum and Instruction (OCI) was founded in 2013 under the Division of Workforce, Career, and Technical Education at the Mississippi Community College Board (MCCB). The office is funded through a partnership with The Mississippi Department of Education (MDE), who serves as Mississippi's fiscal agent for state and federal Career and Technical Education (CTE) Funds. The OCI is tasked with developing statewide CTE curriculum, programming, and professional development designed to meet the local and statewide economic demand.

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ADOPTION OF NATIONAL CERTIFICATIONS

Currently, no national certification exists for Hydrographic Technology.

INDUSTRY JOB PROJECTION DATA

***Based on USBLS Surveying and Mapping Technician. Autonomous maritime systems did not exist in 2010 and Hydrographic Technician (mapping the seafloor) is not yet defined in a standard manner by industry nor is it tracked by USBLS. Therefore, data was collected for Surveying and Mapping Technician.*

https://mdes.ms.gov/information-center/labor-market-information/occupational-employment-and-wages/

* https://mdes.ms.gov/information-center/labor-market-information/occupational-employment-and-wages/
**https://mdes.ms.gov/information-center/labor-market-information/occupational-employment-and-wages/
***https://www.bls.gov/ooh/architecture-and-engineering/surveying-and-mapping-echnicians.htm#tab-6

ARTICULATION

Contact the local community college CTE administration for articulation agreements.
College Directory | Mississippi Community College Board (mccb.edu)

INDUSTRY CREDENTIALS, CERTIFICATIONS, AND PROFESSIONAL LICENSURE

Check the Mississippi Community College Board website for the latest updates:
https://www.mccb.edu/assessment

RESEARCH ABSTRACT

In 2021, industry organizations approached Pearl River Community College about creating a technician course that would train students in hydrographic data collection using autonomous systems. PRCC created a special projects course in collaboration with industry delivered to 5 students over 6 weeks in the summer of 2021. The students were near completion of the PRCC Unmanned Systems Technology Program and therefore had a background in drone operation relevant to maritime systems. These students were able to absorb the compressed special projects course content. Three of the five students were placed with full-time permanent jobs in industry in the weeks following the course.

CURRICULUM JUSTIFICATION

The coastal autonomous systems technician career role consists of skills in seamanship, maritime safety, hydrographic instrument installation/operation/and troubleshooting, hydrographic data collection using side scan/multibeam/sub-profilers, sound velocity profiling, and autonomous surface vehicle launch/recovery/operation/and troubleshooting. (Sullivan & Hochstaedter, 2001) While not formally defined by any standard, this career path currently has a starting salary of $55,000 to $75,000 with an upward salary range of $168,000 in industry according to salary data on ZipRecruiter and other career sites. (ADP, 2021) This job role also fills a critical workforce need for the Navy. (Eckhoff, 2018)

This curriculum recognizes the advancements in autonomous systems and the impact of advanced automation in the dawn of artificial intelligence on mapping the ocean floor. (Christopher, et al., 2020) Hydrography previously

required an advanced degree on the water to properly configure and calibrate equipment, plan data collection, and ensure data is collected to International Hydrography Organization (IHO) standards. Improvements in sonar hardware and software, positioning systems, robotics, and the wide availability of reference data now allow for a technician-level position to handle most of the data collection and much of the processing while certified hydrographers ensure the end products meet rigorous mapping standards. (Noll, 2016)

Executive Order 13840 titled "Ocean Policy To Advance the Economic, Security, and Environmental Interests of the United States" signed June 19, 2018 directs the nation to "modernize the acquisition, distribution, and use of the best available ocean-related science and knowledge" because the waters of the United States are "foundational to the economy, security, global competitiveness, and well-being of the United States". (Office of the President of the US, 2018) The stated mission of the Naval Oceanographic Office is to "optimize seapower by applying relevant oceanographic knowledge in support of U.S. National Security." (DoD, 2021)

The foundation of applying oceanographic knowledge to the advancement of aquaculture, transportation, and defense is mapping the ocean floor. Bathymetric and hydrographic data are essential to both navigation and weather forecasting. Mapping the ocean requires operating in a harsh marine environment to map a surface covered in water that can only be detected and mapped through remote sensing as opposed to direct observation and measurement. This branch of remote sensing, called hydrography, uses sonar to collect nearly all mapping data.

However, there are only 209 certified hydrographers in the United States credentialed to operate according to international hydrographic standards. (THSOA, 2021) The workforce is much larger than that number but are trained on the job with little if any formal training. The current concept of operations also requires an experienced hydrographer, typically with a 4-year degree or higher, for each shift of data collection at sea. (Noll, 2016)

This workforce has a continual requirement to map the world's submerged land covering 70% of the Earth. Autonomous systems are rapidly transitioning from a force multiplier alongside traditional systems to the primary means of data collection. Combined with advanced multibeam and side scan sonar systems, there is now a growing backlog of data requiring processing. The learning curve required to process and create products with hydrographic data using modern software is extremely steep and requires an advanced understanding of oceanography and acoustical physics. Hydrographers with advanced degrees are often deprived of advanced seamanship and instrumentation skills because of their focus on data analysis and software.

Technology and mission requirements are outpacing the legacy hydrographic operational model. The work must be divided among trained technicians performing the bulk of data collection at sea, and advanced hydrographers performing data processing and product generation for multiple projects simultaneously in an office environment for the level of efficiency required to meet the needs of the state and the country.

References

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REVISION HISTORY:
2022, New Program

PROGRAM DESCRIPTION

This program consists of instruction in basic seamanship, maritime safety, hydrographic instrument installation/operation/and troubleshooting, hydrographic data collection using sidescan/multibeam/subprofilers, sound velocity profiling, and autonomous surface vehicle launch/recovery/operation/and troubleshooting.

SUGGESTED COURSE SEQUENCE

Career Certificate Required Courses (Hydrography Technology)

			SCH Breakdown			Contact Hour Breakdown		Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab	Certification Name
GIT 1113	Intro to Hydrography	3	2	2	60			
GIT 1213	Marine Field Methods	3	2	2	60			
GIT 1713	Acoustics for Hydrography I	3	2	2	60			
GIT 2123	Fundamentals of GIS	3	2	2	60			
GIT 2273	Remote Sensing	3	2	2	60			
	Instructor approved electives	15						
	Total	**30**						

Technical Certificate Required Courses (Hydrography Technology)

			SCH Breakdown			Contact Hour Breakdown		Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab	Certification Name
GIT 2143	Advanced Hydrography	3	2	2	60			
GIT 293(1-6)	Hydrographic Special Projects	1-6	0	(2-12)	(30-180)			
	Instructor approved elective	3-6						
	Total	**15**						

Recommended Electives

			SCH Breakdown			Contact Hour Breakdown		Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab	Certification Name
EET 1192	Fundamentals of Electronics	2						
EET 1353	Fundamentals of Robotics	3						
EET 1145 OR EET 1123 AND EET 1114*	DC/AC Circuits OR AC Circuits* AND DC Circuits							
EET 1214	Digital Electronics	4						
EET 2414	Electronic Communication	4						
EET 2433	Physics for Electronics	3						
ANT 2613	Introduction to UAS	3						
ANT 1113	Introduction to Aviation	3						
ANT 2643	Autonomous Systems	3						
	All other electives approved by instructor per local community college policy							

***Colleges choosing to teach AC Circuits and DC Circuits separately as 2 courses for a total of 7 SCH will have less elective hours available in this program of study.**

General Education Core Courses –

To receive the Associate of Applied Science Degree, a student must complete all of the required coursework found in the Career Certificate option, Technical Certificate option and a minimum of 15 semester hours of General Education Core. The courses in the General Education Core may be spaced out over the entire length of the program so that students complete some academic and Career Technical courses each semester or provided primarily within the last semester. Each community college will specify the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science Degree at their college. The Southern Association of Colleges and Schools (SACS) Commission on Colleges Standard 2.7.3 from the Principles of Accreditation: Foundations for Quality Enhancement1 describes the general education core.

Section 2.7.3 In each undergraduate degree program, the institution requires the successful completion of a general education component at the collegiate level that (1) is substantial component of each undergraduate degree, (2) ensures breadth of knowledge, and (3) is based on a coherent rationale. For degree completion in associate programs, the component constitutes a minimum of 15 semester hours or the equivalent. These credit hours are to be drawn from and include at least one course from the following areas: humanities/fine arts, social/behavioral sciences, and natural science/mathematics. The courses do not narrowly focus on those skills, techniques, and procedures specific to a particular occupation or profession.

General Education Courses

			SCH Breakdown			Contact Hour Breakdown		Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab	Certification Name
	Humanities/Fine Arts	3						
	Social/Behavioral Sciences	3						
	College Algebra	3						
	Public Speaking	3						
	English Comp I	3						
	TOTAL	**15**						

[1] Southern Association of Colleges and Schools Commission on Colleges. (2012). *The principles of accreditation: Foundations for quality enhancement*. Retrieved from http://www.sacscoc.org/pdf/2012PrinciplesOfAcreditation.pdf

GIT 1113 Introduction to Hydrography

Description: This course is an introduction to hydrographic survey methods and measurement principles.

Hour Breakdown:

Semester Credit Hours	Lecture	Lab	Contact Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Explain use of hydrographic theory in various sectors of work environment .
    a. Define basic hydrography terminology.
    b. Identify basic industry standards and tools for hydrography.
    c. Identify specific government agencies which utilize hydrography.
    d. Identify private entities which utilize hydrography.
    e. Explain how hydrography theory and practices are used in each sector of business & industry.
2. Demonstrate proper use and operation of hydrographic tools.
    a. Describe and demonstrate the proper techniques for operating a Transducer.
    b. Describe and demonstrate the proper techniques for operating a Side Scan Sonar.
    c. Describe and demonstrate the proper techniques for operating a Multibeam Echo Sounder.
    e. Describe and demonstrate the proper techniques for operating an Acoustic Doppler Current Profiler.
3. Apply proper techniques for data collection, analysis, and dissemination process.
    a. Demonstrate basic knowledge of Python and Excel.
    b. Apply data integrity strategies through troubleshooting data issues.
    c. Demonstrate best practices of file management for storing, organizing and applying naming conventions.
    d. Demonstrate knowledge of QPS - Hydrographic Software Suite.
4. Demonstrate best practices for hydrographic field study.
    a. Coordinate and conduct a pre-trip survey..
    b. Set up and properly calibrate equipment..
    c. Inspect, trouble-shoot, and repair sonar and positioning systems.
5. Describe interconnectedness of specific scientific fields as each relates to the field of hydrography.
    a. (Physics) Define how the basics of wave energy, both light and sound, relate to practice of hydrography.
    b. (Oceanography) Explain how currents and thermoclines (salinity basics of water columns) relate to practice of hydrography.
    c. (Acoustics) Describe how the behavior of sound in water via sonar relate to practice of hydrography.
    d. (Cartography) Translate map projections from a 3D to 2D system and describe how this relates to practice of hydrography.
    e. (Marine Geology) Describe the impact of bottom types (sand, rock, mud, etc.) on the practice of hydrography.
6. Explain concepts and relevance of hydrographic surveys.
    a. Discuss history and development of hydrographic surveys.
    b. Describe the different types of surveys utilized in hydrography: geologic, biologic, archeologic, search & rescue.

GIT 2143 Advanced Hydrography

Description: This course explores advanced acquisition, processing, and the delivery of ocean mapping data.

Hour Breakdown:

Semester Credit Hours	Lecture	Lab	Contact Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Demonstrate advanced data analysis techniques..
    a. Explain proper procedure of the acquisition and control of data..
    b. Apply proper data processing and analysis techniques..
    c. Practice proper remote sensing techniques..
    d. Practice proper remote sensing techniques..
2. Interpret nautical charts.
    a. Interpret and analyze Global Positioning System (GPS) and/or Geographic Information System (GIS) data as it relates to nautical charts..
    b. Interpret and analyze Cartography data (ocean floor mapping to include land and ocean mountains) as it relates to nautical charts..
3. Apply mathematical concepts for Hydrography.
    a. Calculate sound speed (sonar equations) in different environments..
    b. Conduct basic conversions between metric system and imperial system; knots and MPH..

4. Interpret physical oceanography and marine geology for potential mission impact.
    a. Read water currents and predict mission impact.
    b. Detect erosion, determine cause, and describe potential mission impact.
    c. Analyze ocean tide tables to determine water surface level for mapping and potential mission impact.

GIT 1713 Acoustics for Hydrography I

Description: This course explores underwater acoustics and signal processing rudiments associated with hydrography.

Hour Breakdown:

Semester Credit Hours	Lecture	Lab	Contact Hours
5	4	2	90

Prerequisite: Instructor Approved; College Algebra

Student Learning Outcomes:

1. Describe the basic operation of sound underwater.
    a. Explain principles of acoustic wave generation - how sonar specific frequencies relate to data resolution.
    b. Discuss principles of Propagation - how sonar waves move through different environments.
    c. Describe how sonar waves received in different environments impact signal reception.
    d. Explain principles of Thermoclines - how variable water column temperature effects sound speed.
    e. Compare and contrast differences in salinity and conductivity.
2. Demonstrate understanding of Sonar Equation.
    a. Define Sonar Equation.
    b. Apply related formulas to Sonar Equation: survey line overlap calculation, survey speed, and depth to swath width calculation.
    c. Demonstrate advanced operations for data collection and processing using QPS Advanced software.
    d. Identify and apply relevant Sonar Equation Application based on different sonar configurations for different missions. and water bodies.
3. Demonstrate how to evaluate Sonar system performance.
    a. Calculate offsets part of set up for mission.
    b. Identify and overcome data quality issues relative to sonar data collection when conducting a system troubleshooting procedure.
4. Demonstrate proper operation of sonar system aboard a vessel..
    a. System Mobilization - Install and configure sonar equipment and positionings..
    b. System Calibration - Demonstrate proper technique for rub testing and patch testing.
    c. System Positioning - Identify system location and apply the appropriate GPS datum and connect reference stations.
    d. System Communication - Verify connectivity between the sonar collection system, sound velocity probe, and positioning system.
    e. Power System - Evaluate capability of power system and determine if set up for continuous power for entire mission is adequate.
    f. Data Processing Equipment - Estimate if data storage is adequate data storage, pretest system and adjust as needed, and utilize collection software.

GIT 1213 Marine Field Methods

Description: This course is an introduction to data collection, interpretation, and presentation associated with hydrography. Protocols for working aboard a vessel in marine environment to include safety, regulations, nautical terminology, and preparation for documentation to work in the field of Hydrography**.**

Hour Breakdown:

Semester Credit Hours	Lecture	Lab	Contact Hours
3	2	2	60

Prerequisite: Instructor Approved; Boater's Education Certification through Mississippi Department of Wildlife, Fisheries & Parks, MDWFP

Student Learning Outcomes:

1. Explain, demonstrate, and practice general safety procedures in a marine environment.
    a. Demonstrate knowledge of the Boater's Education program..
    b. Demonstrate an understanding of and comply with safety protocols aboard work boats.
    c. Create and implement a Work Deck Management plan.
    d. Demonstrate an understanding of safety protocols and comply with when operating equipment.
    e. Demonstrate an understanding of and comply with OSHA Standards and Guidelines.
    f. Define required Personal Protective Equipment and demonstrate proper wear of PPE.
2. Conduct successful missions while maintaining a safe work environment..
    a. Define and explain nautical terminology.
    b. Create and maintain various nautical Logs (weather, survey, safety) during a mission.
    c. Define marine radio protocols and accurately apply in a marine environment.
    d. Apply for Transportation Worker Identification Card (TWIC).
    e. Apply for US Passport.

GIT 293(1-6) Hydrographic Special Project

Description: This course serves a capstone project for the student in the Hydrographic Technology program wherein the student will plan, execute, and deliver the data as a field project.

Hour Breakdown:

Semester Credit Hours	Lecture	Lab	Contact Hours
(1-6)	0	(2-12)	(30-180)

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. The student will demonstrate how to serve as lead tech in pre-deployment planning.
    a. Develop and implement general safety plan of action for assigned mission.
    b. Demonstrate ability to review weather predictions and forecast according to assigned mission.
    c. Demonstrate installation and configuration of equipment.
2. The student will demonstrate how to serve as lead tech while underway.
    a. Analyze and demonstrate proper layout of equipment and troubleshoot for inaccuracies.
    b. Conduct the deployment and recovery of an Unmanned Systems Vehicle.
3. The student will demonstrate how to serve as lead tech upon return.
    a. Develop and implement a logistics plan for work boat upon return from mission.
    b. Conduct post trip equipment inspections.
4. The student will demonstrate how to serve as lead tech in data processing and product delivery.
    a. Demonstrate ability to collect and analyze data during assigned mission.
    b. Demonstrate ability to disseminate data findings.

RECOMMENDED TOOLS AND EQUIPMENT

CAPITALIZED ITEMS

Item	Purpose
Student Geospatial Workstation	Student Desktop Computer for hydrographic processing
Sea Robotics Surveyor M1.8	Short Range, Shallow Water Hydrographic Unmanned System
Hydrographic Utility Class Drone	Long Range, Deeper Water Hydrographic Unmanned System
Drone Trailers	Used for towing maritime drones
QPS License	Hydrographic Software License
Qinertia Software	Positioning Software for SBG IMU systems
QGIS Software	GIS Software for Map Creation (free)
CloudCompare Software	Software for viewing Point Clouds (free)
USV Test Tank	Tethered Test Tank for training, testing, and servicing drones
Lift Davit	Small crane used to move maritime drones around the lab for testing, training, servicing
Lab Furniture	Student lab tables, chairs, workbenches
Lab Tools	Machinery and tools for servicing unmanned systems
Unmanned system spares	On-hand Replacement parts for program unmanned systems for in-house maintenance and repair
RTK base station	GPS base station used to correct data accuracy
Bench Digital Multimeter	Testing and troubleshooting
Handheld Digital Multimeter	Testing and troubleshooting
Function Generator	Troubleshooting and repairing equipment
AC/DC Power Supply	Power
Oscilloscope	Advanced troubleshooting
Soldier Station	Repair circuit boards
Boat Lease	30 FT to transport equipment and conduct soundings
Kayak	Kayak for retrieving stranded drones

	*Other equipment items can be added when deemed appropriate by the community college industry craft committee or by industry/business training requirements.

NON-CAPITALIZED ITEMS

Item	**Purpose**
Lab safety equipment	Safety glasses, coveralls, gloves, electrostatic discharge equipment
Personal Flotation Devices	Inflatable life vests for teachers and students
Electronic Consumables	Wires, connectors, soldier, components, etc. (yearly)
	*Other equipment items can be added when deemed appropriate by the community college industry craft committee or by industry/business training requirements.

RECOMMENDED INSTRUCTIONAL AIDS

It is recommended that instructors have access to the following items:

Item	**Purpose**
Instructor Computer	Capable of running needed software
Cisco Webex Roomkit Pro	Wall-mounted teaching displays and control unit
Classroom Server	Data Server for classroom projects
IT networking and classroom display control	Systems to link student and instructor computers and displays