

## **Board 107: A Ph.D. in Engineering Degree: Coastal Engineering Emphasis Area**

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## **A PhD in Engineering Degree: Coastal Engineering Emphasis Area**

**Abstract-**Jackson State University approved a Coastal Engineering emphasis area for the PhD Engineering degree in April 2018. This is the first Doctoral engineering degree, among Historic Black Colleges and Universities (HBCUs) that emphasizes coastal engineering focused on coastal natural disasters. A Professor serves as Advisor for graduate students (MS and PhD) enrolled in the Coastal Engineering emphasis area. Minimum degree requirements are 72 credit hours beyond the BS degree or 36 credit hours beyond the MS degree, including 24 hours of dissertation research; a comprehensive qualifying examination, a preliminary examination and a final dissertation defense. Graduates are expected to have at least two publications in recognized professional journals upon graduation. There are eight core coastal engineering courses, one mandatory, of which a minimum of four are required. Practically speaking, the advisor will require six to eight of the core courses depending on the dissertation research focus. Tabular data and graphics depict core course enrollments, number of times they were taught and graduates during the last six academic years. Students may choose the remaining elective courses from the other four coastal engineering core courses and a large variety of civil and environmental engineering courses or other closely related courses (i.e. mathematics, computer science, urban planning, etc.), all requiring approval of their advisor. Laboratory experimental facilities and computational facilities potentially available to students for dissertation research are briefly described. Sources for a supply of PhD coastal engineering students are discussed. Professors in all areas of coastal engineering are available and an example of ongoing coastal engineering research is discussed. The programs coastal natural disaster focus is sponsored by the Office of University Programs, U.S. Department of Homeland Security (DHS). DHS sponsorship is most appropriate in view of Hurricanes Irma, Maria, Harvey, Florence and others within the past twenty four months.

### **Background**

The principle catalyst for the PhD Engineering (Coastal Engineering emphasis area) degree program described in this paper was one of eighteen projects (14 research and 6 education) comprising a competitively awarded Coastal Resilience Center of Excellence cooperative agreement awarded by the Office of University Programs, U.S. Department of Homeland Security (DHS) in 2015 to University of North Carolina as prime. An additional catalyst was the successful MS Engineering (Coastal Engineering emphasis area) program approved by Jackson State University in May 2014 which produced a steady, albeit small, pipeline of two graduates yearly, (about 75% underrepresented African American minority U.S. citizens) over the past six years. This MS Engineering degree, Coastal Engineering emphasis area (emanated from another DHS cooperative agreement awarded to Jackson State University in 2008) has helped build a, mostly local, potential supply of students for the PhD program. Reference [1] describes this MS Engineering program. One objective of these DHS education focused cooperative agreements was to enhance the inclusion of underrepresented minority and female engineers in the coastal hazards engineering profession, particularly those working in the greater Homeland Security Enterprise (i.e. Federal Emergency Management Agency, Coast

Guard, Army Corps of Engineers, state Emergency Management Agencies, state Departments of Transportation, and private industries that contract with federal and state agencies to help mitigate and/or recover from coastal natural disasters.

African American engineers comprise only about 0.5% of all PhD engineers; however, approximately 11.6% of African American PhD engineers graduate from HBCUs. [2] African American PhD engineers prefer to graduate from an HBCU by a ratio of 23:1 (11.6%/0.5%). Consequently, the most practical approach to produce additional African American coastal engineers is to foster a coastal engineering program(s) at an HBCU and that is precisely the rationale for support of this PhD Engineering degree with a coastal engineering emphasis area. The number of MS and PhD Engineering graduates (and those projected for the next two years) along with those in the Coastal Engineering emphasis area are shown in Table 1.

Academic Year	MS Engineering Graduates		MS Engineering (Coastal Engr. Area) Graduates		PhD Engineering Graduates		PhD Engr. (Coastal Engr. Area) Projected Graduates	
	Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative
07/08-12/13	Approved July 2005	55	Approved May 2013					
13/14	15	70	-	-				
14/15	15	85	3	3	Approved May 2015			
15/16	16	101	1	4	-	-		
16/17	17	118	2	6	-	-		
17/18	10	128	2	8	3	3	Approved May 2018	
18/19	16	144	2	10	3	6	-	
Future Projected Graduates								
19/20	15	159	2	12	3	9	1	1
20/21	15	174	2	14	3	12	1	2

Table 1: Past/Future Projected MS/PhD Engineering Graduates from Jackson State University

**Program Description:**

Mission/Objective:

The Jackson State University PhD in Engineering degree program contains eight emphasis areas that are Computer Engineering, Telecommunications Engineering, Electrical Engineering, Computational Engineering, Civil Engineering, Environmental Engineering, Coastal Engineering and Geological Engineering. The first four are administered by the

Electrical and Computer Engineering Department and the latter four are administered by the Civil and Environmental Engineering Department.

The mission of the PhD Engineering degree program is to provide students with the necessary advanced knowledge, research skills, creativity, ethics, critical thinking and problem solving to be able to respond to engineering challenges and needs, of our ever-changing world, for professional competence and life-long inquiry-based learning. The primary educational objective of the PhD in Engineering Program is to produce engineers with terminal degrees to meet the needs for highly educated engineers with advanced technical and research skills in the workforce. Each of the eight emphasis areas has their own specific objectives. Specific objectives of the Coastal Engineering emphasis area follow: To prepare students with advanced knowledge and skills in coastal engineering (including coastal natural disasters) and produce graduates with competencies in advanced original research, education and professional practice in coastal engineering.

#### Degree Requirements:

The PhD Engineering degree requirements include completion of a minimum of 72 semester hours beyond the BS degree or 36 semester hours beyond the MS degree. The program consists of core courses, elective courses and 24 hours of dissertation research. The Advisor and/or the Advising Committee may recommend additional courses based on the students background and proposed research plan. A student must maintain a 3.0 GPA to avoid academic probation.

A comprehensive qualifying examination is administered to the student after a minimum of 6 months, but no later than two years beyond the MS degree. After passing the comprehensive Qualifying Examination, the student is admitted to PhD Candidacy. If a student fails to pass the comprehensive qualifying examination, he/she is allowed to take it again between one and six months after the first attempt. If the student fails twice on this exam, he/she will be dropped from the PhD program.

After completing at least 80% of coursework and passing the comprehensive qualifying examination, students are able to take the preliminary examination administered by the Advising Committee and chaired by the Advisor. This is based on an oral examination and a written proposal and detailed plan to carry out the PhD dissertation research.

The defense of dissertation is the final examination of the PhD program. An oral defense and a written PhD dissertation demonstrating original and independent research and major contributions to an engineering field must be approved by the Advising Committee before graduation. Each graduate is expected to publish at least two papers based on results of his/her research in high quality engineering journals.

#### Core Courses:

The student must select a minimum of four core courses (CIV 520 is required), after consultation with and approval of his/her academic graduate advisor.

<b>Core Courses</b>	<b>Title</b>	<b>Semester Hours</b>
CIV 520	Advanced Engineering Analysis I	3
CIV 538	Coastal Structures	3
CIV 539	Advanced Coastal Engineering Design	3
CIV 558	Sedimentation and River Engineering	3
CIV 631	Linear Theory of Ocean Waves	3
CIV 632	Tides and Long Waves	3
CIV 636	Spectral Wave Analysis	3
CIV 637	Advanced Design for Breakwater Rehabilitation	3

### Elective Courses:

Numerous elective courses are available (with approval of the student's advisor) and most are civil engineering courses that provide the student a flexible graduate program that they can tailor to their preferred areas of study (environmental, water resources, geotechnical, structures, transportation, computational, etc.). Three courses not listed as core courses are CIV 697 Internship, 1-3 hours; CIV 698 Independent Study, 1-4 hours; and CIV 899 Dissertation Research, 1-6 hours. PhD Coastal Engineering emphasis area students may enroll in CIV 697 Internship or CIV 698 Independent Study, as appropriate, for summer research internships or unique coastal research experiences such as research in The Netherlands described in a following section. Dissertation research (CIV 899) must total 24 semester hours upon graduation.

### Education Partnership Agreement

The university has a formal signed Education Partnership Agreement (EPA), authorized by Public Law, with the U.S. Army Corps of Engineers Engineer Research and Development Center (ERDC), a large federal laboratory (\$1.5B/year with over 2500 team members) in the commuting area. The EPA is a catalyst for laboratory/university partnerships that can include equipment loans, adjunct professors, student internships, use of laboratory facilities (experimental and/or computational) and practically any form of mutually agreeable partnership. A formal Cooperative Research and Development Agreement (CRADA) has been signed with ERDC and separate mutually agreeable amendments to the CRADA are entered into for each specific partnership. Several amendments have been signed to date between the University Center of Excellence performing coastal engineering education and research and ERDC. These allow ERDC engineers to be part of the university project team. Experimental and computational assets at ERDC are among the best in the world and include a half dozen wave flumes with spectral wave generators and wave basins with directional spectral wave generators. Computational assets (in the peta flop range) are among the largest capacity worldwide. Subject to appropriate security requirements, these experimental and computational assets can be available to professors and graduate students on a case by case basis.

Several ERDC doctoral coastal engineers have served as Adjunct Faculty. They have taught classes and served on MS and PhD Committees, including participation on Qualifying

Examinations. Full-time tenured coastal engineering faculty have varied from one to two over the past several years and have averaged nearly two/year for the last ten years.

### **Ongoing Coastal Engineering Research**

Most ongoing coastal engineering research is related to large scale innovative storm surge (hurricane) protection for highly complex coastal areas. Specific applications include large areas of coastal Texas (Freeport to the Louisiana border) and coastal New Jersey that contain barrier islands with interconnected back bays, multiple inlets and major ship channels. Such treatments are potentially useful for parts of all state coastal areas on the Gulf of Mexico and east coast from Maine to Florida. This research is funded from two multi-year year research grants; one from National Science Foundation and the other from Department of Homeland Security. One research example is an investigation of the effect of hurricane forward speed on hurricane forerunner amplitude in the greater Houston/Galveston area with some unexpected results for flood levels inside the barrier islands at locations in the back bays relative to flood levels on the open coasts. Combinations of hurricane flood protection and/or mitigation measures are explored that include seawalls, dunes, levees, dikes and temporary gates across canals, bayous, and/or ship channels.

### **Research in The Netherlands**

The university is a partner in a National Science Foundation, Partnership for International Research and Education (PIRE) grant entitled Coastal Flood Risk Reduction with Texas A&M University, Galveston as prime. Other partners are Texas A&M University, College Station and Rice University. The International partner is Delft Technical University. Each year several interdisciplinary teams totaling about 15 US students conduct place based research assessments in specified study areas of The Netherlands. They spend two weeks gathering information to produce a written paper and prepare a formal presentation poster on their research. They are joined by Dutch students in The Netherlands. The primary goal of this binational program is to create authentic learning environments that support and benefit from the research components. Approximately 80 students (beginning in early December) from these four universities compete for 15 slots. [3] Selected students from this university are enrolled in 3 hours of CIV 696 Independent Study during the summer. Each university administers their students as appropriate. There is a mix of PhD, MS and BS students from several disciplines including engineering, landscape architecture, urban planning, etc. There are usually three or four study areas in The Netherlands and each student prepares their own research question(s) and study plan. Five students from this university have been selected and made the trip during the first three years (summers of 2016, 2017 and 2018). All papers prepared by students during the first three years are included in [3]. A sixth student from our university was recently selected to participate in the summer 2019 program. This is a highly unique international research experience and is an invaluable interdisciplinary binational research experience for the student's that participate.

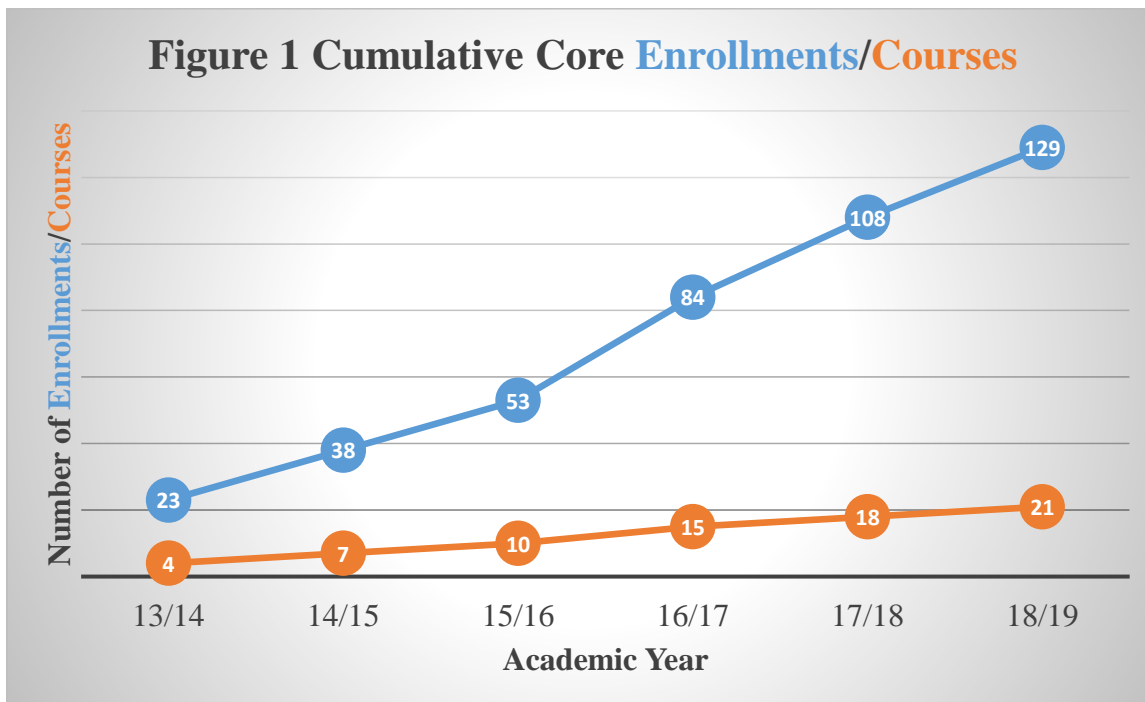
### **PhD Program Participation and Future Plans**

Class size for core courses varies from nominally six to nine students and most core classes are taught every two or three years. A number of students in the Civil Engineering or Environmental Engineering emphasis areas enroll in coastal engineering core courses as electives. CIV 520 is offered yearly and has students from nearly all eight emphasis areas. CIV 538, 539, 631, 636, and 637 are taught every other year and occasionally two out of three years

depending on student enrollment. CIV 558 and 632 are taught about every three years depending on a combination of professor availability (Adjunct) and student demand. Table 2 contains core courses and enrollment data for the past six academic years and these data are illustrated graphically in Figure 1.

Academic Year (AY)	13/14	14/15	15/16	16/17	17/18	18/19
Enrollment Data						
No. of Core Courses Taught	4	3	3	5	3	3
Cumulative Core Courses Taught	4	7	10	15	18	21
No. of Core Course Enrollments	23	15	15	31	24	21
Cumulative Core Enrollments	23	38	53	84	108	129
No. of Independent Research Courses Taught	-	1	4	4	1	1
Dissertation Res. Courses Taught	-	-	-	-	-	1

**Table 2: Course and Enrollment Data (AY 13/14-18/19)**



The majority of engineering graduate students have full time jobs in the local commuting area and enroll in one or two classes a semester. Occasionally a working student will enroll in 3

classes. Nominally 25% of students are full time taking three or four courses per semester. To accommodate this type of working student population, almost 100% of graduate engineering classes meet one day a week for two hours and thirty minutes in the evening with classes starting at 5:30 pm. This also accommodates Adjunct Professors who all have full time positions. Students and Professors may work at the State Department of Transportation, State Department of Environmental Quality, State Department of Emergency Management, U.S. Army Corps of Engineers, a federal laboratory and a large number of design and/or construction engineering firms in the commuting area. The relatively large source for graduate students in the local commuting area is supplemented by a steady and increasing number of inquiries from international students.

Table 1 illustrates the past and projected (for the next two years) MS Engineering and PhD Engineering graduates along with those in the Coastal Engineering emphasis area. There is a small (2 per year) but steady stream of MS (Coastal Engineering area) graduates. The original projection of expected graduates for the PhD Engineering (Coastal Engineering area) was one to two per year with the first expected PhD graduate being in May 2020. That projection appears realistic.

There are currently five PhD students at various stages of their degree plan. Two have completed courses and are PhD Candidates (recently passed Qualifying Exam). One is enrolled in 5 hours of Dissertation research and the other is enrolled in three elective courses related to dissertation research. The student enrolled in Dissertation Research works full time at a nearby government laboratory and is classified as a part time student since he is enrolled in less than 9 semester hours. He is projected to graduate in May 2020 and the other is projected to graduate between May and December 2020. A third is an intermittent student, working full time in Texas, who needs one more course and plans to take the Qualifying Examination in summer 2019. There are two other intermittent PhD students lacking one more course each, working full time in the commuting area and they need to schedule the Qualifying Examination. Table 3 shows the current and projected Examination status of PhD students.

Academic Year	Comprehensive Qualifying Examination	Preliminary Examination	Dissertation Defense Examination
2018/2019	2	-	-
2019/2020	(1)	(2)	-
2020/2021	(2)	(2)	(2)

**Table 3 PhD Student Current/Projected ( ) Examinations**

Currently there are five MS Coastal Engineering area students enrolled, two are expected to graduate in May 2020, the third is an intermittent student working outside the commuting area. Two other enrolled beginning MS students are undecided regarding their emphasis area, but have indicated a preference for the coastal engineering area. Two additional MS students are recruited for Fall 2019. At this time, it appears reasonable that the graduation rate of 2 per year at the MS level and one per year at the PhD level can be sustained and even enhanced slightly.



## Summary

A Coastal Engineering emphasis area in the PhD Engineering degree program has been formally implemented and institutionalized at a Historic Black College and University. This emphasis area has a focus on coastal natural disasters which is articulated in the formal Mission and Objectives for the Program. Five students are enrolled in the PhD Program and two are projected to graduate in 2020. Projections are for a small steady stream of one PhD graduate annually in the Coastal Engineering emphasis area.

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**Disclaimer:** “The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S Department of Homeland Security.”

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