

California State Polytechnic University, Pomona

Academic Senate Report

AS-2695-167-AP

Civil Engineering, M.S. – Environmental and Water Resources Engineering Option

Academic Senate Action:

Adopted: April 5, 2017

Final Disposition:

Transmitted to President: April 10, 2017

**RECOMMENDATION:**

The Academic Senate recommends approval of the Civil Engineering, M.S. - Environmental and Water Resources Engineering Option as part of the semester conversion process (see attached program proposal).

## **Program Proposal**

### **Master of Science in Civil Engineering (MSCE) Environmental and Water Resources Engineering Option**

**Title of the proposed option**

Environmental and Water Resources Engineering Option

**Title of the degree major program under which the option will be offered**

Civil Engineering, Master of Science in Civil Engineering (MSCE)

**Program total units**

30

**Description of Option**

The Civil Engineering Department at Cal Poly Pomona (CPP) proposes to convert an existing Master of Science in Civil Engineering (MSCE) program consisting of emphasis areas into a revised Master of Science in Civil Engineering (MSCE) program consisting of options. The proposed option name for the environmental and water resources engineering emphasis shall be MSCE Environmental and Water Resources Engineering Option. This includes converted courses, revised courses, and new courses as summarized in the Curriculum Sheets. This Program will offer a specialized program of advanced coursework in environmental and water resources analysis and design, and give students in-depth technical knowledge related to the field of Environmental and Water Resources Engineering.

This proposal contains the Curriculum Sheets for the MSCE Environmental and Water Resources Engineering Option, the Roadmap, the 2-Year Course Schedule, the Course Catalog Descriptions, and the Assessment Plan.

**List options or emphases already existing under the degree major program for which the option is proposed.**

Environmental and Water Resources Engineering emphasis  
Geotechnical Engineering emphasis  
Structural Engineering emphasis  
Transportation Engineering emphasis

**State the aims of the proposed option**

The College of Engineering has offered a Master of Science in Engineering (MSE) degree for nearly forty years. Initially, this program included specialty tracks in the various engineering disciplines, including civil engineering. In the late 1990s, the College developed a strategic plan to spin off the more successful specialty tracks into separate degree programs, including the Master of Science in Electrical Engineering (MSEE), the Master of Science in Mechanical Engineering (MSME), and others. The Master of Science in Structural Engineering (MSSE) program was developed in this context, and began in 2001. The program catered primarily to working professional engineers, with classes offered mostly in the evenings. Given the continued success of the MSSE program and with an increasing demand for civil engineers to hold a master's degree in order to advance in their professional career, the Civil Engineering Department obtained approval on July 27, 2006 to change the name of its MS program from MSSE to MSCE. At that time the MSSE program was converted into an emphasis in the MSCE program, concurrently with the addition of the Geotechnical Engineering and Transportation Engineering Emphases to the program. Later in 2015, in response to demand from current students as well as the industry, the Environmental and Water Resources Emphasis was added to the MSCE program. Since then, enrollment has significantly grown and between all emphases, more than 150 students are currently enrolled in the program.

The complexity of contemporary engineering problems faced globally by society requires technical specialization in the different civil engineering technical areas. Furthermore, in response to the societal needs, the American Society of Civil Engineering (ASCE) created the Raise the Bar Strategic Initiative to advance the profession and the public welfare by actively supporting the national movement to raise educational requirements for licensure of future professional engineers. This initiative includes the increase of the in-depth level of technical training fulfilled with additional 30 credits of graduate or upper level undergraduate courses in engineering and professional practice topics. The recommendations are presented at [http://www.asce.org/raise\\_the\\_bar/](http://www.asce.org/raise_the_bar/). The conversion of the MSCE emphases to MSCE options will allow the Civil Engineering Department to provide a more concentrated in-depth technical experience for the students enrolled in each of the options, while including the multidisciplinary and broader professional experience in the technical electives offered in the option's curriculum. The proposal to convert the existing emphasis to an option is aligned to the goals of ASCE's Body of Knowledge for the 21st Century ([http://www.asce.org/civil\\_engineering\\_body\\_of\\_knowledge/](http://www.asce.org/civil_engineering_body_of_knowledge/)).

The conversion from the Environmental and Water Resources Engineering Emphasis to an Environmental and Water Resources Engineering Option will offer the opportunity to specify in the MSCE degree the area of technical expertise for each student. This will help the department recruit well-qualified students and enhance the opportunities for our graduates to be employed in the environmental and water resources engineering field. An added benefit of converting the emphasis into an option is that it will be possible to track student enrollment and track student progress towards graduation. Student tracking will facilitate student advising and streamline course offerings.

**List courses by subject area, catalog number, title, and units of credit as well as the total units to be required under the proposed option**

Refer to the Curriculum Sheets included in this proposal.

**Justify the need for the proposed option.**

Local industries have looked to the Civil Engineering Department for graduates to fill internships, part-time and full-time positions in environmental and water resources engineering. Our graduates are well sought after by both private companies and public agencies for employment. The industry trend in the area of environmental and water resources engineering is that a Master's Degree is the minimum requirement for employment even at an entry level position. By converting the Environmental and Water Resources Engineering Emphasis to an Environmental and Water Resources Engineering Option, the graduates' degree will identify the area of expertise which will open opportunities for them in sectors that would otherwise not be accessible.

In addition, the enhancement of our existing MSCE program by converting the Environmental and Water Resources Engineering Emphasis into an Environmental and Water Resources Engineering Option is an essential part of the department's strategic plan to ensure continued success and professional growth of our graduates and ensure lifelong learning and development of our alumni.

The proposed changes in the MSCE program will allow the Civil Engineering Department to continue supporting and expanding the MSCE Program and will facilitate the recruitment of well-qualified faculty in environmental and water resources engineering.

**List new courses to be developed. You will need to submit separate course proposals for each new course.**

Refer to the curriculum sheets included in this proposal.

**List all present faculty members with rank, appointment status, highest degree earned, date and field of highest degree, and professional experience, who would teach in the proposed option.**

1. **Lourdes V. Abellera**, Assistant Professor; full-time; Ph.D. (2005) in Civil Engineering with an emphasis in Environmental Engineering; she is a licensed Geodetic Engineer in the Philippines. Her expertise is in Geographic Information Systems (GIS) for water resources, water quality, and transportation.
2. **Kenneth Lamb**, Assistant Professor, full-time, Ph.D. (2010) in civil engineering with an emphasis in Water resources engineering. He is a licensed civil engineer in Nevada with expertise in Water & Sewer Planning and System Design, as well as in Water Supply Forecasting.
3. **Bruce Mansell**, part-time instructor, Ph.D., P.E. Engineer in the development area of LA Sanitation District. He is a licensed civil engineer in California, with expertise in water reclamation and membrane applications in wastewater treatment.
4. **Mónica Palomo**, Associate Professor, full-time, Ph.D., in civil engineering with an emphasis in environmental engineering (2008), master's degrees in civil engineering with

emphasis in environmental engineering (2003). She is a licensed civil engineer in California with expertise in process design in water and wastewater treatment, water quality, and solute transport.

5. **Seema Shah-Fairbank**, - Associate Professor, full-time, Ph.D. in civil engineering with an emphasis in water resources engineering (2009). She is a licensed civil engineer in California with expertise in river mechanics, sediment transport and hydrology.
6. **Mohamadali Sharbatmaleki**, Assistant Professor, full-time, Ph.D., with specialty in civil engineering. He is licensed in Nevada with expertise in water and wastewater treatment, and membranes systems.

**Describe instructional resources (faculty, space, equipment, library volumes, etc.) needed to implement and sustain the proposed option.**

The resources currently utilized to run the MSCE Environmental and Water Resources Engineering Emphasis (faculty, classrooms, computer labs, library resources) would be adequate to run the Environmental and Water Resources Engineering Option. Because the MSCE courses are offered in the evening, the needed resources do not interfere with those required to properly run the B.S. Civil Engineering Program.

**List additional resources needed including specific resource, cost, and source of funding.**

No additional resources are needed to properly run the proposed Environmental and Water Resources Engineering Option.

## CURRICULUM SHEET

<b>Program Name: MSCE Civil Engineering – Environmental and Water Resources Engineering Option</b>				
<b>Total Units: 30</b>				
<b>Required Major Core Courses – Units: 3-9</b> (CE 5020 is common core course for all MSCE students; culminating experience is satisfied by CE 6970, CE 6950, or CE 6960)				
<b>Course Number</b>	<b>Title</b>	<b>Units (lec/lab)</b>	<b>Revised/ Converted</b>	<b>GE Area Double Count (Y/N)</b>
CE 5020	Applied Probability Concepts in Civil Engineering	3	Converted	N
CE 6950	Master’s Project	3	Converted	N
or CE 6960	Master’s Thesis	3 (6 units required)	Converted	N
or CE 6970	Comprehensive Examination	0	Revised	N
<b>Required Option Core Courses – Units: 12</b>				
<b>Course Number</b>	<b>Title</b>	<b>Units (lec/lab)</b>	<b>Revised/ Converted</b>	<b>GE Double Count (Y/N)</b>
CE 6210	Municipal Hydraulic Systems	3	Converted	NA
CE 5211	Applied Hydrology	3	Revised	NA
CE 6250	Advanced Water Treatment	3	Converted	NA
CE 6260	Advanced Wastewater Treatment	3	Converted	NA
<b>Option Elective Courses - Units 9-15</b>				
<b>Course Number</b>	<b>Title</b>	<b>Units (lec/lab)</b>	<b>Revised/ Converted</b>	<b>GE Double Count (Y/N)</b>
CE 6200	Environmental and Water Resources Seminar	1	Converted	NA
CE 5271	Unit Operation and Processes for Environmental Engineering	3	Converted	NA
CE 5220	Solid and Hazardous Waste Engineering	3	Converted	NA
CE 5280	River Mechanics	3	Converted	NA
CE 5290	Global Climate and Water Supply	3	Converted	NA
CE 5261	Air Quality Engineering	3	Revision	NA
CE 5241	Environmental Remediation	3	Revision	NA
CE 5201	Environmental Chemistry	3	Revision	NA

**Civil Engineering Department  
MSCE EWR Option  
Curriculum Year: 2018-2019**

*Your department has developed this road plan, taking into account prerequisites and schedule restrictions.*

*You should pay attention to these concerns when deviating from this plan.*

		Fall	Units	Spring	Units	Comment		
<b>Year 1</b>		<b>CE 5020</b> Applied Probability Concepts in Civil Engineering	3	<b>CE 6260</b> Advanced Wastewater Treatment	3	<i>The three columns in a semester refer to the three possible culminating experiences: Master's Thesis, Master's Project, or Comprehensive Exam,, respectively</i>		
		<b>CE 6210</b> Municipal Hydraulic Systems	3	<b>CE 5211</b> Applied Hydrology	3			
		<b>CE 6250</b> Advanced Water Treatment	3	<b>CE XXXX</b> Option Elective	0/0/3			
		<b>Total Units</b>	<b>9</b>	<b>Total Units</b>	<b>6/6/9</b>			
				<b>Total Units for Year</b>	<b>15/15/18</b>			
		Fall	Units	Spring	Units	Comment		
<b>Year 2</b>		<b>CE XXXX</b> Option Elective	3	<b>CE XXXX</b> Option Elective	3	<i>The three columns in a semester refer to the three possible culminating experiences: Master's Thesis, Master's Project, or Comprehensive Exam,, respectively</i>		
		<b>CE XXXX</b> Option Elective	3	<b>CE 6960</b> Master's Thesis	<b>CE 6950</b> Master's Project		<b>CE 6970</b> Compr. exam	3/3/0
		<b>CE 6960</b> Master's Thesis	<b>CE XXXX</b> Option Elective	<b>CE XXXX</b> Option Elective				3/3/3
		<b>Total Units</b>	<b>9/9/9</b>	<b>Total Units</b>	<b>6/6/4</b>			
				<b>Total Units for Year</b>	<b>15/15/12</b>			
<b>Total Units on Plan</b>					<b>30</b>			
<b>Option Required Units</b>					<b>15/15/15</b>			
<b>Option Elective Units common to all paths</b>					<b>9/12/15</b>			
<b>MSCE program Common Units</b>					<b>3</b>			
<b>Master's Thesis Path</b>					<b>6</b>			
<b>Master's Project Path</b>					<b>3</b>			
<b>Comprehensive Exam</b>					<b>0</b>			

## CE Projected Two- Year Course Schedule

Please refer to BroncoDirect for the current academic quarter course schedule

Course	Academic Year 2018-19			Academic Year 2019-2020		
	Fall	Spring	Summer	Fall	Spring	Summer
CE 5020	X			X		
CE 5201					X	
CE 5211					X	
CE 5220				X		
CE 5241	X					
CE 5251				X		
CE 5261						X
CE 5271		X				
CE 5280		X				
CE 5290				X		
CE 5310	X			X		
CE 5990						
CE 5990L						
CE 6200	X	X		X	X	
CE 6210	X					
CE 6250				X		
CE 6260		X				
CE 6500	X			X		
CE 6681					X	
CE 6900	X			X		
CE 6950	X	X		X	X	
CE 6960	X	X		X	X	
CE 6970		X			X	
CE 6990	X	X	X	X	X	X

**California State Polytechnic University, Pomona**  
**Civil Engineering Department**  
**Graduate Program Assessment Plan**  
**Environmental and Water Resources Option**  
**(Semesters)**

December 2, 2016

The Master of Science in Civil Engineering (MSCE) program at Cal Poly Pomona builds upon an undergraduate education and facilitates more advanced studies in one of the branches of civil engineering. The program consists of 30 semester units. Currently, there are four emphases under the MSCE program: Environmental and Water Resources Engineering, Geotechnical Engineering, Structural Engineering, and Transportation Engineering. These emphases will be converted into options.

This Assessment Plan describes the meaning of the MSCE degree, including the program educational objectives and student outcomes. It also details the process of assessing and improving the level of performance in achieving these objectives and outcomes and upholding the quality and integrity of the degree.

### **Meaning of the MSCE Degree**

The MSCE degree provides students with advanced knowledge and understanding of civil engineering principles and practices, which they apply to solve civil engineering problems. It enables the graduate to articulate the significant challenges confronting the field utilizing a solid foundation of advanced courses. Through a careful selection of challenging projects, students propose creative approaches to solving contemporary civil engineering problems. These project experiences distinguish the MSCE graduate by providing them with the analysis and design background necessary to tackle complex civil engineering projects using state-of-the-art methods. Graduates with the MSCE degree are expected to attain certain Program Educational Objectives (PEOs) within a few years of graduation and demonstrate certain Student Outcomes (SOs) at the time of graduation. These PEOs and SOs are given below:

### **Program Educational Objectives**

Program Educational Objectives are broad statements that describe what MSCE graduates are expected to attain within a few years of graduation. Graduates of the MSCE program will be able to:

1. Apply advanced technical knowledge to analyze and design civil engineering projects.
2. Demonstrate professional-level communication, teamwork, leadership, and lifelong learning skills.

3. Demonstrate a high level of individual, professional, and social responsibility.

**Student Outcomes**

Student Outcomes are the knowledge, skills, and values MSCE graduates are expected to demonstrate at the time of graduation. Graduates of the MSCE program will have:

1. An ability to design and conduct experiments, as well as to analyze, interpret, and explain data.
2. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3. An ability to identify, formulate, analyze and solve engineering problems.
4. An ability to plan, compose, and integrate the verbal, written, virtual, and graphical communication of a project to technical and non-technical audiences.
5. An ability to evaluate the design of a complex system or process, or evaluate the validity of newly created knowledge or technologies in a traditional or emerging advanced specialized technical area appropriate to civil engineering.

Table 1 shows the relationship between the PEOs and SOs.

**Table 1: Relationship between Program Educational Objectives and Student Outcomes**

Program Educational Objectives	Student Outcomes				
	SO1	SO2	SO3	SO4	SO5
PEO1	X	X	X		X
PEO2			X	X	X
PEO3		X			X

**Mapping of Student Outcomes to Required and Elective Courses**

The five SOs listed above (SO1 to SO5) and the required courses and elective courses aimed at providing students with practice and mastery of these outcomes for Environmental and Water Resources Engineering Option are mapped in Table 2.

**Table 2 Course-to-Student Outcome Map: MSCE Environmental and Water Resources Engineering Option**

Course No.	Course Title	Required/ Elective	SO1	SO2	SO3	SO4	SO5
CE 5020	Applied Probability Concepts in Civil Engineering	Elective	P	P			
CE 6210	Municipal Hydraulic Systems	Required		P	P	P	M
CE 5211	Applied Hydrology	Required	P	P	P	P	P
CE 6250	Advanced Water Treatment	Required	P	P	P	P	P
CE 6260	Advanced Wastewater Treatment	Required	P	P	P	P	P
CE 6200	Environmental and Water Resources Seminar	Elective				P	
CE 5271	Unit Operation and Processes for Environmental Engineering	Elective	P		P	P	P
CE 5220	Solid and Hazardous Waste Engineering	Elective	P	P	P	P	P
CE 5280	River Mechanics	Elective	P	P	P	P	P
CE 5290	Global Climate and Water Supply	Elective		P	P	P	M
CE 5261	Air Quality Engineering	Elective	P	P	P		P
CE 5241	Environmental Remediation	Elective	P		P	P	P
CE 5201	Environmental Chemistry	Elective	P		P		
CE 6500	Advanced Engineering Math	Elective			P		
CE 5310	GIS Applications in Civil Engineering	Elective	P	P	M	P	P
CE 6681	Advanced Computer Programming in Civil Engineering	Elective	P	P	P	P	P
CE 6950	Master's Project	Required	M	M	M	M	M
CE 6960	Master's Thesis	Required	M	M	M	M	M
CE 6970	Comprehensive Examination	Required	M	M	M	M	M

P: Practice; M: Master

### **Assessment Plan**

The level of achievement of the PEOs and SOs will be assessed through collecting and analyzing data from courses and other means. Assessment data in the form of direct and indirect measures will be collected. Examples of direct measure data include:

- A. Performance on embedded final exam problems
- B. Quality of Master's Project reports and Master's Theses
- C. Performance on oral presentations of Master's Projects and Theses
- D. Performance of Comprehensive Exam in how students apply knowledge gained in course work to solve real and open-ended engineering situations
- E. Performance of Comprehensive Exam in how students synthesize knowledge gained in course work to advance solutions of real and open-ended engineering problems
- F. Quality of written term papers and course project reports
- G. Performance on oral presentations of written term papers and design project reports

Examples of indirect measure data include:

- H. Results of exit survey of graduating students
- I. Results of survey of graduates
- J. Results of survey of employers of graduates

The Civil Engineering Department Graduate Committee will analyze collected assessment data, discuss the analysis results, and develop and implement an action plan to improve the program.

A general assessment plan schedule is given in Table 3 to show the schedule of assessment data collection and action plan discussion and development for each SO. Table 3 also shows the kinds of data to be collected (identified by the letters in the list of data above). The courses from which data will be collected in each semester will be determined from the actual course offerings for the semester.

The PEOs will be assessed by collecting data (Data G. and H. listed above) once every three years or twice per ABET accreditation cycle, starting in 2018-19.

**Table 3 Assessment Plan Schedule**

	<b>F 18</b>	<b>S 19</b>	<b>F 19</b>	<b>S 20</b>	<b>F 20</b>	<b>S 21</b>	<b>F 21</b>
<b>SO1</b>	<b>C</b> <b>(Data</b> <b>A. to</b> <b>C.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>A. to C.,</b> <b>and F.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>A. to</b> <b>C.)</b>	<b>D</b>	
<b>SO2</b>	<b>C</b> <b>(Data</b> <b>A. to E.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>A. to F.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>A. to E.)</b>	<b>D</b>	
<b>SO3</b>		<b>C</b> <b>(Data</b> <b>B. and</b> <b>C.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>B., C.</b> <b>and F.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>B. and</b> <b>C.)</b>	<b>D</b>
<b>SO4</b>		<b>C</b> <b>(Data</b> <b>B. and</b> <b>C.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>B., C.</b> <b>and F.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>B. and</b> <b>C.)</b>	<b>D</b>
<b>SO5</b>		<b>C</b> <b>(Data</b> <b>B. and</b> <b>C.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>B., C.</b> <b>and F.)</b>	<b>D</b>	<b>C</b> <b>(Data</b> <b>B. and</b> <b>C.)</b>	<b>D</b>

**C:** Collection of direct or indirect data identified by letter(s) in data list

**D:** Discussion of data analysis results and development of action plan to improve program

<b>COURSE NUMBER</b>	<b>UNITS</b>	<b>COURSE TITLE</b>	<b>COURSE DESCRIPTION</b>
CE 5020	3	Applied Probability Concepts	Modeling uncertainty in civil engineering projects. Numerical and graphical data analysis. Common probability distributions. Hypothesis testing and confidence intervals. Regression analysis and curve fitting. Monte Carlo simulations. Reliability and reliability based design. Elements of decision theory.
CE 5201	3	Environmental Chemistry	The course provides an introduction to primarily aqueous-phase equilibria governing water quality characteristics of interest in portable water supply, wastewater treatment and natural waters. Specific topics covered include acid-base and metal-ligand equilibria, oxidation-reduction reactions and chemical reaction thermodynamics. There is some emphasis on equilibria governing inter-phase (gas-liquid, solid-liquid) chemical distribution. Mathematical approaches to prediction of equilibrium chemical speciation are stressed. Graduate-level requirements include the application of computer algorithms to solve equilibrium chemistry problems.
CE 5211	3	Applied Hydrology	Hydrology as it is applied to storm water management. Evaluation of the ever changing regulations associated with storm water quality. Use/develop stochastic and process based hydrologic and hydraulic models. Based on the water quality regulations, hydrologic analysis and hydraulic analysis develop engineering solutions to the urban watershed. Further details will be provided associated with hydrographs, river routing and reservoir routing.
CE 5220	3	Solid and Hazardous Waste Engineering	This course will cover principles of integrated solid waste management and fundamentals of hazardous waste management and engineering. The course will cover the following elements: waste generation, storage, collection, transfer, transport, processing, recovery, disposal of municipal and industrial solid waste. The course will also include: hazardous waste identification, accumulation, minimization, transport, and development of a hazardous waste contingency plan to comply with disposal restrictions.
CE 5241	3	Environmental Remediation	This course will cover fundamentals of physical, chemical, and biological environmental

			remediation and cleanup. The course will cover the following elements: environmental chemistry, environmental microbiology, water contaminations, soil contaminations, air contaminations, physical methods, chemical methods, biological methods, pollution prevention strategies, regulations and future trends.
CE 5251	3	Groundwater Mechanics	Physics of subsurface groundwater flow, including storage, compressibility, capillarity and Darcy's Law in porous media. Shallow confined and unconfined flows. Two-dimensional flow in vertical plan. Flow toward wells. Determination of streamlines and flow lines in two and three dimensions. Introduction to contaminant transport. Elementary computer modeling.
CE 5261	3	Air Quality Engineering	Basic concepts in physics and chemistry of the atmosphere. Production, transformation, transport, and removal of air pollutants. The problems of photochemical smog, the greenhouse effect & climate change, stratospheric ozone, acid rain, and visibility. Analytical techniques for gases and particles. Numerical simulation of air pollution. Health and environmental effects of air pollution.
CE 5271	3	Unit Operation and Processes in Environmental Engineering	The study of various physical, chemical and biological operations and processes used in the professional practice of environmental engineering (water treatment, wastewater treatment, and soil remediation). Topics covered will be selected from areas such as reactor hydrodynamics, oxidation-reduction, coagulation-flocculation, chemical precipitation, ion exchange, adsorption process, biological oxidation, anaerobic digestion, activated sludge.
CE 5280	3	River Mechanics	Foundation for understanding sediment transport and erosion in the river environment. Topics include: sediment properties; resistance to flow; incipient motion and bed forms; sediment transport; reservoir sedimentation; and river restoration.
CE 5290	3	Global Climate and Water Supply	Intersection of global climate, water and energy topics. Discussion of the relationship between energy and water demand and cover current developments in research and technology related to climate, water, and energy. Application will

			focus on identifying the links between climate, water and energy and the stewardship of scientists, policy makers and society at large and on the efficient design of systems affected by climate.
CE 5310	3	GIS Applications in Civil Engineering	Introduction to fundamental concepts and techniques of geographic information systems (GIS). GIS applications in transportation, environmental assessment, water resources management, geo-environmental analyses and other areas in civil engineering.
CE 5990	1-3	Special Topics for Graduate Students	Selected topics comprising new or experimental courses not otherwise offered. Each offering identified in the current schedule and on the student's transcript.
CE 5990L	1-3	Special Topics for Graduate Students Laboratory	Selected topics comprising new or experimental courses not otherwise offered. Each offering identified in the current schedule and on the student's transcript.
CE 6200	1	Environmental Water Resources Seminar	Current research topics and engineering projects in the area of Environmental and Water Resources and related fields.
CE 6210	3	Municipal Hydraulic Systems	Planning, design, and analysis of various types of hydraulic systems used to deliver potable or irrigation water, collect sewage, and convey storm water. Computer modeling techniques for each of these systems that can be used for planning and design of new facilities, or the analysis of existing facilities.
CE 6250	3	Advanced Water Treatment	Physical and chemical principles as applied to water treatment plant design. Advanced water treatment processes such as reverse osmosis, advanced oxidation, ion exchange, and ozonation will be considered in the design or improvement of water treatment facilities.
CE 6260	3	Advanced Wastewater Treatment	Principles of applied biotechnology used in various biological processes in wastewater treatment plant design. Advanced biological processes for BOD, nitrogen, and phosphorous removal, and membrane bioreactors will be considered in the design or improvement of wastewater treatment plants.
CE 6500	3	Advanced Engineering Mathematics	Matrices, eigenvalue problems, differential equations, partial differential equations, Fourier series and Fourier transforms.

CE 6681	3	Advanced Computer Programming in Civil Engineering	This course will give students a detailed discussion on the concepts of mobile programming. It will introduce students to Java and Android programming technologies. Students will use Java programming language to develop mobile apps in civil engineering. After completing the course, students should have solid computer programming skills in Java and establish hands-on experience in mobile applications to solve civil engineering problems.
CE 6900	1	Research Methods	Emphasis on how to do applied research in civil engineering. It covers the entire research process including: 1) identifying research problems or issues, 2) formulating strategies for solving problems, 3) writing proposals, 4) developing plans and schedules, 5) conducting research, and 6) writing papers and reports. It also discusses strategies and methodologies effective in each phase of the research process.
CE 6950	2-3	Master's Project	Individual and independent work based on the project proposal, plan and scheduled approved by advisor. Regular meetings and discussions with advisor.
CE 6960	2-6	Master's Thesis	Individual and independent research work based on the project proposal, plan and scheduled approved by advisor. Regular meetings and discussions with advisor.
CE 6970	0	Comprehensive Examination	Comprehensive examination in partial fulfillment of Master's degree.
CE 6990	0	Master's Degree Continuation	Continued work on a Master's Project or Thesis after a student has completed the number of required units of CE 6950 or CE 6960. This course permits such students to remain in residency during the graduation quarter.