3.1 ABOUT THE INSTITUTE

Civil Engineering is the branch of engineering involved in the conceptualization, planning, design, construction and operation of systems, facilities and infrastructures needed for maintaining and supporting modern civilization. These include, among others, shelters, buildings, towers, site and slope protection systems, tunnels, bridges, streets, highways, rails, airports, ports and harbors, coastal structures, water distribution systems, irrigation, drainage, flood control, canals, dams, and corresponding technologies for natural disaster risk management and for environment management.

Infrastructure is regarded as one of four main factors of global competitiveness, along with: economic performance, government efficiency, and business efficiency. Specifically considered are basic infrastructure, technological infrastructure, scientific infrastructure, health and environment, and education. Infrastructure, including overall infrastructure, transportation, communication, energy and others, is likewise regarded as one of nine pillars of global competitiveness index. The situation calls urgently for the strengthening of our national capabilities for infrastructures of all types, including civil engineering.

The University of the Philippines has a long and distinguished record in civil engineering education and research. Immediately after the establishment of the College of Engineering in 1910, the 4-year curriculum offered was for a degree of Bachelor of Science, requiring an additional year of study that led to the degree of Civil Engineer with the first graduates produced in 1915. Revision of the curriculum was immediately made then, to a 4-year course leading to a degree of Bachelor of Science in Civil Engineering. The 4-year curriculum, with occasional changes in the required courses, stayed on until 1953 when the 5-year curriculum was adopted in the various disciplines.

While the 5-year curriculum for B.S. CE has had occasional changes since, major changes have been approved by the University in 2008 with the introduction of a three-course series on analytical and computational methods in civil engineering, and introduction of specialization in any of the six major fields of civil engineering through research and integration courses at the senior year. It is expected that the new curriculum will develop the scientific-technological attributes as well as the humanistic-social attributes of an ideal well-rounded UP civil engineering graduate.

Within a few years from the establishment of the College, the Master of Science in Civil Engineering program was instituted with first graduates produced in 1919. About 90 years later in 2004, the Doctor of Philosophy Program in Civil Engineering was instituted, with various available fields of specialized study. It was the first offering Ph.D. in Civil Engineering program in the Philippines.

In October 2008, the University approved the transformation of the Department to an Institute with the creation of the Institute of Civil Engineering to address the growing need for a center of excellence in civil engineering and its specialized fields, with combined capabilities in instruction, research and extension service. It first and only Institute of Civil Engineering in the country.

3.2 VISION

It is our vision to be an internationally recognized institution in instruction, research, and extension service, in civil engineering and its specialized fields.

3.3 MISSION

Our mission is to nurture a culture of academic excellence, technological proficiency, and social relevance, and to synergize with interrelated institutions in the college, the university, the nation and the region.

3.4 UNDERGRADUATE PROGRAM

Bachelor of Science in Civil Engineering

The Bachelor of Science in Civil Engineering (B.S. CE) degree is the main undergraduate program of the Institute, currently with specialized undergraduate research project options in the following fields:

- Construction Engineering & Management
- Geotechnical Engineering
- Structural Engineering
- Transportation Engineering
- Water Resources & Coastal Engineering
- Environment & Energy Engineering

The B.S. CE curriculum is designed to give the graduate a balanced education in the six specialized fields of civil engineering as well as the social sciences and humanities – a recognition that technical solutions in civil engineering problems must consider the socioeconomic, legal, political, and environmental aspects.

3.4.1 Program Educational Objectives

The program educational objectives of the B.S. Civil Engineering program are the following:

- Objective 1: Graduates will become practicing engineers, consultants, technocrats, educators, and/or researchers in the various fields of civil engineering or other related or emerging fields,
utilizing, generating, and sharing engineering knowledge and experience.

- Objective 2: Graduates will continue their lifelong learning process, through graduate studies, or other professional education to remain effective professionals.

- Objective 3: Graduates will be in leadership positions and be recognized as highly competent, critical, creative, independent thinkers, and imbued with good citizenship values.

- Objective 4: Graduates will play key roles in the solution of increasingly complex engineering problems as well as in the solution of issues that are important to the Philippine society in particular.

3.4.2 Program Outcomes

The following are the program outcomes of the B.S. Civil Engineering program according to four clusters:

C – Core Competencies
- ICE1. an ability to apply knowledge of mathematics, science, and engineering
- ICE2. an ability to design and conduct experiments, as well as to analyze and interpret data, having a thorough understanding of scientific method and engineering method
- ICE3. 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
- ICE4. an ability to identify, formulate, and solve engineering problems

E – Enabling Competencies
- ICE5. an ability to function on multidisciplinary teams, having good interpersonal skills and a grasp of the fundamentals of running an enterprise
- ICE6. an ability to communicate effectively, organizing thoughts logically and presenting them clearly and concisely by written, verbal and/or graphic means

V – Values
- ICE7. an understanding of professional and ethical responsibility
- ICE8. a broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- ICE9. an understanding of the past, to appreciate the present and plan for the future

D – Drivers
- ICE10. a recognition of the need for, and an ability to engage in life-long learning
- ICE11. a knowledge of contemporary issues in the profession and the society
- ICE12. active contribution to nation-building

The long existing B.S. CE program of the Institute is well-recognized nationally and internationally. All graduates are readily employed. Among the graduates who apply for higher graduate degrees and scholarships abroad, most are readily admitted. The recognition is further supported by external assessments conducted by national and international bodies on the B.S. Civil Engineering program.

In 2012-2013, the B.S. Civil Engineering program at the University of the Philippines Diliman has been assessed and found to be in accordance with the requirements of the standard details of the ASEAN University Network Quality Assurance (AUN-QA) certification. The AUN-QA certification is valid from 6 August 2013 to 5 August 2017 (Certificate No: AP14UPJUL13).

The B.S. CE curriculum and undergraduate course offerings may be found in Sections 3.10 and 3.12 of this catalogue.

3.5 GRADUATE PROGRAMS

Admission into the Program

Admission into the Master’s Program in Civil Engineering requires a B.S. degree in Civil Engineering or its allied fields from a recognized institution of higher learning.

Admission into the Doctoral Program in Civil Engineering requires:
1) M.S. degree in Civil Engineering (or a B.S. degree in Civil Engineering) or its allied fields from a recognized institution of higher learning; and,
2) a demonstrated high degree of intellectual capacity and aptitude for advanced study and research.

Fields of Study

The Master of Science in Civil Engineering and Doctor of Philosophy in Civil Engineering have the following four fields of study:
- Structural Engineering
- Geotechnical Engineering
- Transportation Engineering
- Water Resources Engineering

3.5.1 Master of Science in Civil Engineering

The Master of Science in Civil Engineering (M.S. CE) degree may be obtained through either the Thesis or Non-Thesis option.
Thesis Option

To qualify for the Master’s Degree under the Thesis Option, a student must satisfy the following requirements:

1) complete a minimum of twenty-four (24) units of formal graduate courses;

2) maintain a cumulative weighted average grade (CWAG) of 2.00 or better in his/her graduate courses at the end of each academic year;

3) successfully defend a Master’s Thesis; and,

4) submit at least five bound and certified copies of the approved Master’s Thesis.

Non-Thesis Option

To qualify for the Master’s Degree under the Non-Thesis Option, a student must satisfy the following requirements:

1) complete a minimum of thirty (36) units of formal graduate courses;

2) maintain a cumulative weighted average grade (CWAG) of 2.00 or better in his/her graduate courses at the end of each academic year;

3) pass the Master’s Comprehensive Examination.

Additional requirements over and above these minimum University requirements and standards for the Master’s Degree programs may be adopted by the college with the approval of the appropriate bodies.

3.5.2 Doctor of Philosophy in Civil Engineering

To satisfy the requirements for the Doctor of Philosophy in Civil engineering (Ph.D. CE) program, a student must satisfy the following:

1) complete the following minimum course requirements

   a) for M.S. degree holders
   
      Courses in the Major field  12 units
      Core courses in Civil      6 units
      Engineering
      Electives                  6 units
      Dissertation               12 units
      Total number of units      36 units

b) for B.S. degree holders, straight Ph.D.

   Courses in the Major field  24 units
   Core courses in Civil      9 units
   Engineering
   Electives                  12 units
   Dissertation               12 units
   Total number of units      57 units

2) maintain a cumulative weighted average grade (CWAG) of 1.75 or better at the end of each academic year until the completion of the program of study;

3) pass the qualifying examination after completion of all course work in the program of study, and those units stipulated by the residence rules, if applicable; and,

4) submit a doctoral dissertation and successfully defend the dissertation.

The curricula and course offerings for the master’s and doctoral programs may be found in Sections 3.11 and 3.13.

3.6 ACADEMIC GROUPS

The Institute has six academic groups with the corresponding research agenda.

Construction Engineering & Management Group

- Sustainable Housing
- Disaster-Resilient Construction
- Durable Infrastructure
- Construction Methods and Management

Geotechnical Engineering Group

- Characterization of Indigenous Geo-materials
- Construction in Problematic Geotechnical Conditions
- Assessment and Mitigation of Risk Related to Geotechnical & Geo-Environmental Hazards

Structural Engineering Group

- Monitoring, Assessment, Evaluation, Rehabilitation and Retrofit of Existing Structures
- Design, Development and Testing of New and Alternative Infrastructure Systems
- Loss Estimation and Risk Analysis
- Non-destructive Testing of Existing Structures
- Design and Development of Structural Analysis Software for Research and Instruction
### Water Resources & Coastal Engineering Group
- Water Resource Utilization, Planning and Management
- Water-Related Disasters
- Climate Change including Eco-System Change
- Coastal Engineering

### Environment & Energy Engineering Group
- Water Quality Control and Management
- Wastewater Treatment
- Solid Waste Management
- Geo-Environmental Engineering
- Disaster Risk Reduction Management
- Sustainable Infrastructure

### Transportation Engineering Group
- Traffic Flow Theory and Analysis
- Sustainable Transport
- Travel Demand Management and Modelling
- Transport Safety
- Transport, Environment and Energy

### 3.7 ACADEMIC AND RESEARCH FACILITIES

#### Construction Materials and Structures Laboratory (CoMSLab)
The Construction Materials and Structures Laboratory (CoMSLab) supports the instruction, research and extension activities of the Institute. It is the instruction laboratory for the undergraduate class in construction materials as well as for the graduate course in soil and rock testing.

It also hosts the experiments of students doing their undergraduate research under the construction materials and geotechnical engineering tracks. CoMSLab is also equipped to handle routine tests of common construction materials and it accepts testing requests from industry and other government clients as part of its extension activities. The laboratory also caters to requests for special tests as well as contract research on a case to case basis.

#### Civil Engineering Computational Laboratory
Inaugurated in November 2005, this instructional laboratory is equipped with computing facilities that are used by civil engineering students and faculty in courses requiring computations. The laboratory is located at Room MH 235 of Melchor Hall.

#### Institute Facilities in the UP Diliman Engineering Complex
The building infrastructures and laboratory facilities of the Institute recently received a major upgrade. From its present location at the College of Engineering building along Osmeña Avenue in the Academic Oval, the Institute will soon transfer to its new site in the Engineering Complex site along C.P. Garcia Avenue.

The Institute is one of the beneficiaries of the on-going ten-year multi-billion peso program of the national government called the ‘Engineering Research and Development for Technology (ERDT)’ through the construction of new classrooms, office and laboratory facilities in the Engineering Complex.

Recently completed are the Office and Classroom Wing (OCW) building, laboratory buildings L1, L2, L3, L5, and a Utility building. OCW is the main building for classes, faculty offices, computational laboratories, and graduate students’ workstations. A 300-capacity acoustic-treated theater is also available with breakout rooms for workshops and conferences. The Utility building contains the control system for power supply and standby electric generating set. L1 houses the laboratory facilities of the Structural Engineering Group including a 3m×3m bi-directional shaking table and a 7m-tall reaction wall. L2, which is contiguous with L1, houses the laboratory facilities of the Construction Engineering and Management Group. L3 houses the laboratory facilities of the Geotechnical Engineering Group. L5 is a stand-alone laboratory building for fire-related research.

The next phase of construction will see the rise of laboratory building L4 of Water Resources and Coastal Engineering Group and the contiguous building L6/L7/L8 housing the laboratories of the Transportation Engineering Group (L6), the Environment and Energy Engineering Group (L7) and the laboratory administrative office (L8) of the Institute. The ICE Building is designed to utilize gray water from rains, with 2 of the 3 cistern compartments already built, and will have a Materials Recovery Facility in the next phase to properly treat its solid wastes according to environmental standards. Proposals are underway to build a wind tunnel facility and a coastal engineering laboratory, equipped with a 30m-long wave flume and a multi-directional wave generator on a 12m×20m wave basin.

The UP-ICE Compound (Offices, Classrooms and Laboratories)
3.8 SUPPORTING RESEARCH CENTERS

Three research and extension-service Centers were also established over the years that continue to involve civil engineering faculty members and students. These are the U.P. Building Research Service (UP-BRS), established in 1971, the U.P. National Hydraulic Research Center (NHRC), established in 1973, and the U.P. National Center for Transportation Studies (UPNCTS), established as the Transport Training Center in 1976. Extension services of these Centers have been closely linked to the instruction and research activities in the various fields of civil engineering. The classroom, library, office space, computing and laboratory facilities of these Centers have been supporting academic, research and extension activities of the Institute.

3.9 FACULTY AND STAFF

There are 48 full-time faculty members, composed of 14 professors, 6 associate professors, 10 assistant professors and 18 instructors with 19 doctoral degree holders and 11 master’s degree holders in the various fields of study in civil engineering.
Institute Director

Dr. Ricardo G. Sigua

Professors

Alexis Philip A. Acacio
Ph.D. Civil Engineering (Geotechnical Engineering) University of Tokyo, 1997
Geotechnical Engineering, Lean Construction, Construction Systems Improvement

Peter P. M. Castro
M. Eng. (Water Resources Development) Asian Institute of Technology, 1978
Hydraulics and Water Resources Engineering, Mitigation of Flood and Sediment Disasters

Eric C. Cruz
Dr. Eng. Civil Engineering (Coastal Engineering) University of Tokyo, 1994
Coastal Engineering, Coastal Hydrodynamics and Structures, Nearshore Process Modeling

Fernando J. Germar
Ph.D. Civil Engineering (Structural Engineering) University of the Philippines Diliman, 2011
Earthquake Engineering, Design of Reinforced Concrete Structures, Design of Steel Structures, Construction Management

Ulpiano P. Ignacio, Jr.
Ph.D. Civil Engineering University of the Philippines Diliman (in progress)
Earthquake Engineering, Structural Analysis, Risk and Loss Estimation

Alfredo B. Junio, Jr.
M.S. Civil Engineering (Structural Engineering) University of Illinois at Urbana Champaign, 1982
Finite Element Method Applications in Structures, Structural Design

Benito M. Pacheco
Ph.D. Civil Engineering (Structural Engineering) University of Tokyo, 1987
Bridge, Building, Earthquake, Wind, Fire, Vibration, Risk Management

Jose Regin F. Regidor
Dr. Eng. Civil Engineering (Transportation Engineering) Yokohama National University, 1999
Traffic Engineering, Sustainable Transport, Trip Generation

Augustus C. Resurreccion
Ph.D. Biological and Environmental Science Saitama University, 2007
Environmental Soil Physics, Vadoze Zone Hydrology

Ricardo G. Sigua
Ph.D. Civil Engineering (Transportation) University of Tokyo, 1991
Traffic Engineering, Traffic Flow Theory, Intelligent Transportation Systems (ITS)

Guillermo Q. Tabios III
Ph.D. Civil Engineering (Hydrology and Water Resources) Colorado State University, 1984
Stochastic and Computational Hydrology and Hydraulics, Water Resources Systems Engineering

Maria Antonia N. Tanchuling
Ph.D. Civil Engineering (Geo-Environmental Engineering) Tokyo Institute of Technology, 2005
Solid Waste Management, Water and Sanitation, Environmental Impact Assessment

Karl B. N. Vergel
Dr. Eng. Civil Engineering (Transportation) Tokyo Institute of Technology, 1999
Transportation and the Environment and Energy, Vehicle Standards

Mark Albert H. Zarco
Ph.D. Civil Engineering (Geotechnical Engineering) Virginia Polytechnic Institute and State University, 1993
Landslide Risk Assessment and Mitigation, Computational Geomechanics

Associate Professors

Oscar Victor M. Antonio, Jr.
Dr. Eng. Civil Engineering (Nondestructive Evaluation) Tokyo Institute of Technology, 2011
Nondestructive Evaluation (Superstructures and Foundations), Structural Health Monitoring, Indigenous Geomaterials

Benjamin R. Buensuceso, Jr.
D. Eng. (Geotechnical Engineering) Asian Institute of Technology, 1990
Foundation Engineering, Pile Testing

Nathaniel B. Diola
Dr. Eng. Civil Engineering (Concrete Technology) Tokyo Institute of Technology, 1999
Cement, Concrete and Other Construction Materials, Durability of Structures, Sustainable Construction

Cornelio Q. Dizon
M.S. Water Resources University of the Philippines Diliman, 1987
Hydraulic Modeling, Hydrologic Modeling, Design of Water Supply Systems
Jaime Y. Hernandez, Jr.  
Ph.D. Civil Engineering  
University of Tokyo, 2007  
Structural Dynamics, Structural Health Monitoring

Eric Augustus J. Tingatinga  
Ph.D. Civil Engineering  
Saitama University, 2008  
Earthquake Engineering, Structural Dynamics, Seismic Building Vulnerability

Assistant Professors

Diocel Harold M. Aquino  
M.S. Civil Engineering (Structural Engineering)  
University of the Philippines Diliman, 2014  
Disaster Risk Management, Fire Engineering

Jeane B. Camelo  
M. Eng. Civil Engineering (Coastal and Ocean Engineering)  
Oregon State University, 2011  
Coastal Engineering, Modeling of Nearshore Processes, Coastal Sediment Transport, Coastal Geomorphology, Air Pollution Control

Ma. Brida Lea D. Diola  
M.S. Environmental Engineering  
University of the Philippines Diliman, 2014  
Water Quality Management and Modeling, Heavy Metal Transport in Rivers, Solid Waste Management

Eugene C. Herrera  
Dr. Eng. Mechanical and Environmental Informatics and Engineering  
Tokyo Institute of Technology, 2010  
Watershed Hydrology, Inland and Coastal Water Hydrodynamics, Water Quality

Romeo Eliezer U. Longalong  
M.S. Civil Engineering (Structural Engineering)  
University of the Philippines Diliman, 2015  
Collapse Simulation, Risk and Loss Estimation

Christian R. Orozco  
M.S. Environmental Engineering  
University of the Philippines Diliman, 2014  
Water and Wastewater Treatment and Management, Surface Water Quality Monitoring and Modeling, Sustainable Materials in Engineered Systems, Environmental Impact Assessment

Hilario Sean O. Palmiano  
Dr. Eng. Human Built Environment (Transportation Planning and Engineering)  
Tokyo Institute of Technology, 2003  
Transportation Engineering, Traffic Management, Road Safety, Sustainable Transport, Traffic Micro-Simulation

Roberto S. Soriano  
Ph.D. Civil and Environmental Engineering  
University of New South Wales, 2004  
Surface and Groundwater Flow Interactions, Aquifer Recharge, Groundwater Modelling

Pedro T. Templo, Jr.  
M.S. Civil Engineering  
Colorado State University, 1980  
Construction Engineering and Management, Hydrology and Water Resources

Jaime Angelo S. Victor  
M.S. Civil Engineering (Geotechnical Engineering)  
University of the Philippines Diliman, 2015  
Geomaterials, Foundation Engineering

Instructors

Albino O. Aguilar III  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
Construction Management

Kristian M. Azul  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
Earthquake Studies

Dominic M. Bautista  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
Water Resources Engineering

Rosabelle Louise A. Caram  
B.S. Civil Engineering  
University of the Philippines Diliman, 2014  
Environmental Engineering

John Michael G. Constantino  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
Transportation Engineering

Jessica M. Junio  
B.S. Civil Engineering  
University of the Philippines Diliman, 2015  
Earthquake Engineering, Pervious Concrete, Carbon Nanotube

Maxell P. Lumbera  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
Climate Change, Hydrology and Hydraulics

Richmark N. Macuha  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
Hydropower Development, Disaster Risk Management, Climate Change Adaptation, Sediment Transport
INSTITUTE OF CIVIL ENGINEERING

William L. Mata  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
*Structural Engineering, Wind Engineering, Earthquake Engineering, Structural Health Monitoring*

Mathew Harvey T. Peralta  
B.S. Civil Engineering  
University of the Philippines, 2014  
*Structural Engineering*

Raniel M. Suiza  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
*Disaster Risk Management, Structural Design*

Liezl Raissa E. Tan  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
*Earthquake Engineering, Risk and Loss Estimation, Vulnerability Curves, Structural Assessment*

Noriza R. Tibon  
M.S. Environmental Engineering  
University of the Philippines Diliman (in progress)  
*Environmental Engineering*

Lestelle V. Torio-Kaimo  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
*Geotechnical Hazards Monitoring and Mitigation, Foundation Engineering, Earth Structure Analysis*

Ian Howell S. Tungol  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
*Structural Engineering*

Giancarlo P. Ventura  
B.S. Civil Engineering  
University of the Philippines Diliman, 2015  
*Slope Stability Analysis, Disaster Risk Mitigation*

Mary Jane F. Venus  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
*Non-Destructive Testing*

Imee Bren O. Villalba  
M.S. Civil Engineering  
University of the Philippines Diliman (in progress)  
*Water Resources Engineering, Coastal Engineering*

**Professorial Lecturers**

Rafael R. Angangco  
Angel L. Lazaro III  
Leonardo Q. Liongson

**Senior Lecturers**

Gerardo M. Angeles  
Benjie M. Dimaculangan  
Miguel L. Dimadura  
Michael V. Gonzalez  
Ronaldo S. Ison  
Edgardo P. Kasilag II  
Roy Anthony C. Luna  
Jesus N. Matias  
Ruiji P. Medina  
Mark K. Morales  
Cherry B. Rivera  
David S. Rojas, Jr.  
Jose Carlo Eric L. Santos  
Michael Allan E. Sicat  
Frederick Francis M. Sison

**Lecturers**

Elvin B. Cruz  
Joanna O. Esparagoza  
Marie Claire L. Pascua

**Administrative Staff**

Ms. Elsie I. Opinaldo  
Ms. Marissa R. Rullan  
Ms. Bibiana C. Zalazar  
Mr. Rodolfo R. Miras (ICE CoMSLab)  
Mr. Nestor G. Pasco (ICE CoMSLab)  
Mr. Edwin C. Regidor (ICE CoMSLab)  
Ms. Marissa L. Tibayan (ICE CoMSLab)

**CONTACT INFORMATION**

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Email:  
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Website:  
ice.upd.edu.ph
### Undergraduate Program Curriculum

#### Bachelor of Science in Civil Engineering

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<td>CE 163 (Geotechnical Engineering II)</td>
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<td><strong>Second Semester</strong></td>
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<td>GE (AH 5) Free Choice</td>
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<td>GE (SSP 5) Free Choice</td>
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<td>GE (MST 3) STS (Science, Tech &amp; Society)</td>
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<td>CE 142 (Transportation Engineering II)</td>
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<td>PI 100 (The Life &amp; Works of Jose Rizal)</td>
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<td>CE 157 (Design of Reinforced Conc Members)</td>
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<td>CE 199 (Undergraduate Research Project)</td>
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<td>CE 190 (Seminar &amp; Research Methods in CE)</td>
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<td>1</td>
<td>Elective 2 6</td>
<td>3</td>
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Total Number of Units = 182

### Notes:

- Effective AY 2015-2016. Total Number of Units = 182
- Kas 1 and Fil 40 satisfy the 6-unit Philippine Studies requirement
- Nine (9) units of GE (AH) courses must be in Communication in English
- Except for Math 1, GE (MST) Math, Chem, Geol, ES, GE, EEE cannot be credited as GE courses
- For physical education (PE), the student is required to complete any 4 physical education (PE) courses
- As a requirement for graduation, all students must take six (6) units in one of the National Service Training Program (NSTP) components:
  - Civic Welfare Training Service (CWTS), Literacy Training Service (LTS), and Reserved Officer’s Training Corps Military Science (ROTC Mil Sci)
- With Institute approval, this will enable the student to choose from among the major tracks of civil engineering
- (Qualified Electives: CE 113, 114, 125, 133, 134, 135, 143, 158, 164, CE 197, CE 198, Arch 55, EgyE 101, Geog 31)
3.11 GRADUATE PROGRAMS CURRICULA

Master of Science in Civil Engineering (M.S. CE)

Field of Study: Geotechnical Engineering

Program Checklist

A. Required Major/Specialization Courses
- CE 260 Soil & Rock Testing 3 units
- CE 261 Soil & Rock Mechanics 3 units
- CE 262 Foundation Engineering 3 units
- CE 264 Geotechnical Engineering 3 units

B. Applied Mathematics
- ES 201 Advanced Mathematical Methods in Engineering I 3 units
- ES 204 Numerical Methods in Engineering 3 units

C. Elective Major/Specialization Courses
- CE 263 Soil & Rock Dynamics 3 units
- CE 265 Soil & Rock Engineering Problems 3 units
- CE 266 Earth Structures 3 units
- CE 268 Critical State Soil Mechanics 3 units
- CE 269 Ground Improvement Techniques 3 units
- CE 297 Special Topics 3 units
- CE 298 Special Problems 3 units

D. Elective*

E. Thesis
- CE 300 Thesis 6 units

Minimum Requirements for the Thesis Option and Non-Thesis Option

<table>
<thead>
<tr>
<th></th>
<th>Thesis Option</th>
<th>Non-Thesis Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Major/Specialization Courses</td>
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<td>12 units</td>
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<td>Applied Mathematics</td>
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<tr>
<td>Elective Major/Specialization Courses</td>
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<td>9 units</td>
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<td>Elective*</td>
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<td>9 units</td>
</tr>
<tr>
<td>Thesis</td>
<td>6 units</td>
<td>not required</td>
</tr>
<tr>
<td>Comprehensive Examination</td>
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<tr>
<td>Total</td>
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<td>36 units</td>
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</table>

*Refer to Notes on Elective Courses for the Master’s Program

Grade requirement: CWAG of 2.00 or better

Notes:
1. CE 297 may be taken twice on two different topics for a maximum credit of six (6) units.
2. To obtain the degree, a student must have a cumulative weighted grade average of 2.00 or better, and write and successfully defend a thesis or must pass a comprehensive examination.
Master of Science in Civil Engineering (M.S. CE)

Field of Study: Structural Engineering

Program Checklist

A. Required Major/Specialization Courses
   • CE 226 Structural Dynamics 3 units
   • CE 257 Discrete Methods of Structural Analysis 3 units
   • ES 230 Continuum Mechanics I 3 units

B. Applied Mathematics
   • ES 201 Advanced Mathematical Methods in Engineering I 3 units
   • ES 204 Numerical Methods in Engineering 3 units

C. Elective Major/Specialization Courses
   • CE 201** Matrix Theory of Structures 3 units
   • CE 222 Advanced Concrete Technology 3 units
   • CE 250 Pre-Stressed Concrete 3 units
   • CE 252 Design of Metal Structures 3 units
   • CE 253 Design of Reinforced Concrete Structures 3 units
   • CE 255 Theory of Plates & Shells 3 units
   • CE 256 Structural Design for Dynamic Effects 3 units
   • CE 258 Plastic Structural Analysis & Design 3 units
   • CE 259 Earthquake Engineering 3 units
   • CE 291 Bridge Design 3 units
   • CE 297 Special Topics 3 units
   • CE 298 Special Problems 3 units

D. Elective*

E. Thesis
   • CE 300 Thesis 6 units

** Upon advice by Program Adviser, taken among the first courses (see Note below)

Minimum Requirements for the Thesis Option and Non-Thesis Option

<table>
<thead>
<tr>
<th></th>
<th>Thesis Option</th>
<th>Non-Thesis Option</th>
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<td>Elective*</td>
<td>3 units</td>
<td>9 units</td>
</tr>
<tr>
<td>Thesis</td>
<td>6 units</td>
<td>not required</td>
</tr>
<tr>
<td>Comprehensive Examination</td>
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<td>required</td>
</tr>
<tr>
<td>Total</td>
<td>30 units</td>
<td>36 units</td>
</tr>
</tbody>
</table>

*Refer to Notes on Elective Courses for the Master’s Program

Grade requirement: CWAG of 2.00 or better

Notes:

1. CE 201 is required for non-UP B.S. graduates who have not taken the undergraduate course in Matrix Theory of Structures. Additional three (3) units are required over the minimum. The grade is included in computing the cumulative weighted grade average.
2. ES 202 may be taken as substitute for ES 201.
3. CE 297 may be taken twice on two different topics for a maximum credit of six (6) units.
4. To obtain the degree, a student must have a cumulative weighted grade average of 2.00 or better, and write and successfully defend a thesis or must pass a comprehensive examination.
Master of Science in Civil Engineering (M.S. CE)
Field of Study: Transportation Engineering

Program Checklist

A. Required Major/Specialization Courses
- CE 240 Transportation Systems Analysis & Planning 3 units
- CE 246 Transportation & Traffic Surveys 3 units
- CE 248 Traffic Flow Theory & Analysis 3 units
- CE 249 Planning and Design of Transportation Facilities 3 units

B. Applied Mathematics
- ES 201 Advanced Mathematical Methods in Engineering I 3 units
- ES 204 Numerical Methods in Engineering 3 units

C. Elective Major/Specialization Courses
- CE 241 Airport Engineering 3 units
- CE 242 Traffic Engineering & Management 3 units
- CE 243 Highway Engineering 3 units
- CE 244 Port & Harbor Engineering 3 units
- CE 245 Mass Transit Engineering 3 units
- CE 247 Transportation Economics & Evaluation 3 units
- CE 297 Special Topics 3 units
- CE 298 Special Problems 3 units

D. Elective*

E. Thesis
- CE 300 Thesis 6 units

Minimum Requirements for the Thesis Option

<table>
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<tr>
<th></th>
<th>Thesis Option</th>
<th>Non-Thesis Option**</th>
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<tr>
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<td>Thesis</td>
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<tr>
<td>Comprehensive Examination</td>
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<tr>
<td>Total</td>
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*Refer to Notes on Elective Courses for the Master’s Program

**Non-thesis option is not available for this field of study

Grade requirement: CWAG of 2.00 or better

Notes:
1. CE 297 may be taken twice on two different topics for a maximum credit of six (6) units.
2. To obtain the degree, a student must have a cumulative weighted grade average of 2.00 or better, and write and successfully defend a thesis or must pass a comprehensive examination.
Master of Science in Civil Engineering (M.S. CE)
Field of Study: Water Resources Engineering

Program Checklist

A. Required Major/Specialization Courses
   • CE 211  Free Surface Flow  3 units
   • CE 212  Applied Hydrology  3 units
   • CE 213  Advanced Hydrology  3 units
   • CE 214  Groundwater Development  3 units
   • CE 215  Water Resources Planning  3 units
   • ES 251  Intermediate Fluid Mechanics  3 units

B. Applied Mathematics
   • ES 201  Advanced Mathematical Methods in Engineering I  3 units
   • ES 204  Numerical Methods in Engineering  3 units

C. Elective Major/Specialization Courses
   • CE 217  Hydraulic Design  3 units
   • CE 270  Fundamental Coastal Hydrodynamics  3 units
   • CE 273  Coastal Sediment Transport  3 units
   • CE 297  Special Topics  3 units
   • CE 298  Special Problems  3 units
   • EnE 210  Water Quality Control and Management  3 units

D. Elective*

E. Thesis
   • CE 300  Thesis  6 units

Minimum Requirements for the Thesis Option and Non-Thesis Option

<table>
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<th>Thesis Option</th>
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<tr>
<td>Thesis</td>
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<td>Comprehensive Examination</td>
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<tr>
<td><strong>Total</strong></td>
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*Refer to Notes on Elective Courses for the Master's Program

Grade requirement: CWAG of 2.00 or better

Notes:
1. CE 297 may be taken twice on two different topics for a maximum credit of six (6) units.
2. To obtain the degree, a student must have a cumulative weighted grade average of 2.00 or better, and write and successfully defend a thesis or must pass a comprehensive examination.
Notes on Elective Courses for the Master’s Program

With Institute approval, courses to be credited as Elective may be chosen from:

a) the Common List of Elective Courses for the Master’s Program shown below; and,
b) among major/specialization courses (required and elective) from other M.S. Civil Engineering Fields of Study.

The Institute may, from time to time, add or delete courses from the list of elective courses. Graduate courses from the College of Engineering, the School of Statistics and the School of Urban and Regional Planning, for example, have been approved as elective subjects by graduate advisers.

Common List of Elective Courses for the Master’s Program

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<td>CE 216</td>
<td>Theory of Plasticity</td>
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<td>CE 219</td>
<td>Hydraulic Measurements</td>
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<td>CE 220</td>
<td>Soil Erosion &amp; Sedimentation</td>
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<td>CE 225</td>
<td>Advanced Construction Engineering</td>
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<td>CE 236</td>
<td>Environmental Benefits and Costs in Civil Engineering Projects</td>
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<td>CE 251</td>
<td>Structural Safety &amp; Reliability</td>
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<td>CE 296</td>
<td>Seminar</td>
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<td>ES 202</td>
<td>Advanced Mathematical Methods in Engineering II</td>
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<td>Mechanics of Vibration</td>
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<td>ES 250</td>
<td>Similitude in Engineering</td>
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Doctor of Philosophy in Civil Engineering (Ph.D. CE)

Program Checklist

<table>
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<th>With B.S. degree</th>
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<td>Minimum Total</td>
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Notes on Courses for the Doctoral Program

Courses in the doctoral program are classified according to fields of study. Other relevant courses may be courses offered by the Institute of Civil Engineering or other departments/institutes in the College of Engineering and the University and they are chosen according to the needs and relevance to the program of study of the student.

1. List of Core Courses

   A. Common Core Courses

      CE 301  Environmental Impact Assessment in Civil Engineering Projects
      CE 304  Probabilistic Methods in Civil Engineering
      CE 306  Finite Element Methods in Civil Engineering I

   B. Geotechnical Engineering

      CE 360  Geotechnical Testing and Instrumentation
      CE 361  Advanced Soil Mechanics

   C. Structural Engineering

      CE 322  Advanced Topics in Concrete Technology
      CE 350  Advanced Structural Analysis
      CE 351  Random Structural Vibrations
      CE 352  Advanced Design of Metal Structures
      CE 353  Advanced Design of Reinforced Concrete Structures
      CE 356  Advanced Structural Dynamics
      CE 358  Wind Engineering

   D. Transportation Engineering

      CE 340  Advanced Transportation Systems Analysis and Planning
      CE 341  Advanced Traffic Flow Theory and Analysis
      CE 342  Advanced Traffic Engineering and Management
E. Water Resources Engineering

- CE 311 River Mechanics and Sediment Transport Modeling
- CE 313 Stochastic Techniques in Water Resources
- CE 315 Mathematical Modeling of Water Resources Systems
- CE 316 Optimization and Simulation of Water Resources Systems
- CE 318 Groundwater Flow and Contaminant Transport

2. Major/Specialization Course: With Institute approval and recommendation of the Graduate Adviser, the student may also take major/specialization courses in the master’s program.

3. Elective: With Institute approval and recommendation of the Graduate Adviser, courses to be credited as Elective may be chosen from:
   a) the List of Common Elective Courses shown below;
   b) among major/specialization courses from other Ph.D. Civil Engineering Fields of Study; and,
   c) among major/specialization (required and elective) and common elective courses from the M.S. Civil Engineering Program.

The Institute may, from time to time, add or delete courses from the list of elective courses.

List of Common Elective Courses

- CE 307 Finite Element Methods in Civil Engineering II
- CE 308 Mechanics of Fracture and Fatigue
- CE 397 Special Topics in Civil Engineering
- CE 398 Special Problems in Civil Engineering
3.12 UNDERGRADUATE PROGRAM COURSE DESCRIPTIONS

Civil Engineering (CE)

CE 14 Solid Mechanics. Introduction to continuum mechanics. Special topics in mechanics, such as non-homogeneous members, inelastic behavior, unsymmetrical bending, torsion, energy methods and applications. Prereq: ES 13. 3 u.


CE 16 Fluid Mechanics for Civil Engineering II. Principles of similitude and dimensional analysis. Application to closed-conduit flow, flow around immersed bodies and open-channel flows. Case studies in pipe flow, flow through structures, flow around civil works structures, and flow through porous media. Prereq: CE 15. 4 h (1 lec, 3 lab) 2 u.


CE 22 Engineering Economy. The fundamentals of engineering decisions. Relative economy of alternative materials, methods, processes, designs. Prereq: 4th year standing. 3 u.

CE 26 Analytical and Computational Methods in Civil Engineering I. Programming concepts and methods; algorithms and software; matrix operations; concepts of discrete mathematics. Prereq: Math 53. 5 h (2 lec, 3 lab) 3 u.

CE 27 Analytical and Computational Methods in Civil Engineering II. Eigenvalue problems; nonlinear equations; function approximations; ordinary differential equations; analytical and numerical solutions of ordinary differential equations; vector analysis. Prereq: Math 53, CE 26. 5 h (2 lec, 3 lab) 3 u.

CE 28 Analytical and Computational Methods in Civil Engineering III. Partial differential equations; analytical and numerical solution of partial differential equations; Fourier series; tensor analysis; calculus of variations. Prereq: CE 27. 5 h (2 lec, 3 lab) 3 u.

CE 49 City Planning. Historical background of modern city planning. Some legal aspects of planning such as zoning laws, building codes, and private deed restrictions. Problems in site planning with relation to physical conditions, landscape construction and costs. Use of contour maps, layout of roads, grouping of buildings, surface and subsurface drainage, utilities, and community services. Prereq: GE 12. 1 u.

CE 110 Hydrology. Weather and hydrologic cycle; precipitation, evaporation, transpiration and infiltration; groundwater flow; rainfall-runoff relations; unit hydrograph; storage and channel routing; flood and drought frequency analysis. Prereq: CE 15, CE 21. 3 u.

CE 111 Hydraulic Engineering. Sizing of reservoirs; hydraulic analysis and design of dams, spillways, gates, outlet works, open channels and pressure conduits; sediment transport; pipe network analysis; theory of hydraulic machinery. Prereq: CE 16. 3 u.

CE 112 Water Resources Engineering. River engineering; flood and sediment control; drainage; irrigation; hydropower; water supply; inland navigation; multi-purpose projects; integrated water resources management. Coreq: CE 110, CE 111. 3 u.

CE 113 Coastal Engineering. Water waves, short- and long-term analysis, wave generation, tides and water levels, wave transformation and breaking, wave forces, design of structures, shore processes, shore protection, computational tools. Prereq: CE 16, CE 162. 3 u.

CE 114 Multipurpose Water Resources Development. Graphic and analytical optimization techniques; optimization by simulation; planning and implementation. Prereq: CE 112. 3 u.

CE 121 Construction Materials. Engineering properties of common construction materials (soils, aggregates, concrete, metals, wood and composites); concrete mix design; standard test methods; non-destructive testing; testing of small-scale structural elements. Prereq: ES 13, CE 21. 5 h (2 lec, 3 lab) 3 u.
CE 123 Construction Engineering and Management I. Project development process, personalities, and project organization; legal and ethical aspects of the Civil Engineering profession; project documents and service engagement procedures; contract administration. Prereq: CE 121. 3 u.

CE 124 Construction Engineering and Management II. Cost engineering, productivity, quantitative methods for construction, site lay-out, planning and scheduling, construction equipment and methodology; pricing and bid strategy; network analysis, resource allocation; software application. Prereq: CE 22, CE 123. 3 u.

CE 125 Construction Engineering and Management III. Site management; total quality approach, problem solving and decision-making, effective communication, motivation and leadership, resource management. Prereq: CE 124. 3 u.


CE 133 Sanitary Engineering II. Engineering applications of new concepts of physical-chemical wastewater treatment. Prereq: CE 132. 3 u.


CE 135 Environmental Geotechnology. Landfill control and uses; contaminated groundwater and seepage; soil/environment and soil/pollutant interaction; hazardous waste control and storage systems; durability and protection of geostuctural members hazardous ground. Prereq: CE 131, 162. 3 u.

CE 141 Transportation Engineering I. Characteristics of transportation systems; introduction to transportation planning; traffic flow fundamentals; traffic control fundamentals; transportation and traffic surveys. Coreq: CE 21; Prereq: CE 27. 3 u.

CE 142 Transportation Engineering II. Planning and design of transportation facilities; road, rail, air and water transportation. Coreq: GE 12, CE 141, CE 162. 3 u.


CE 156 Design of Steel Members. Behavior and design of structural steel members subject to axial load, flexure, shear and combined loads. Connection design. Prereq: CE 155. 3 u.

CE 157 Design of Reinforced Concrete Members. Behavior and design of reinforced concrete members subject to axial load, flexure, shear. Serviceability requirements. Prereq: CE 155. 3 u.


CE 162 Geotechnical Engineering I. Geomorphology; phase relationships; soil plasticity; soil classification; mechanics of soils; shear strength of soils; compressibility of soils; soil permeability and seepage analysis. Prereq: Geol 11, ES 13, CE 15. 5 h (2 lec, 3 lab) 3 u.

CE 163 Geotechnical Engineering II. Site investigations; lateral earth pressures; earth retaining structures; slope stability; bearing capacity and settlements; shallow and deep foundations; ground improvement techniques. Prereq: CE 162. 3 u.


CE 180 Seminar. Prereq: SS. 3 h (lab) 1 u.
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CE 190 Seminar and Research Methods in Civil Engineering. Development of research proposal. Prereq: COI. 3 h (lab) 1 u.

CE 197 Special Topics. Prereq: COI. 3 u.; may be taken twice, topics to be indicated for record purposes.

CE 198 Special Problems. Prereq: Candidacy for graduation. 3 u.

CE 199 Undergraduate Research Project. Implementation of research project. Prereq: CE 190. 7 h (1 lec, 6 lab) 3 u.

3.13 GRADUATE PROGRAMS COURSE DESCRIPTIONS

Civil Engineering (CE)

CE 201 Matrix Theory of Structures. Structural theorems and strain energy concepts; matrix network formulation of structural analysis; vector transformations; linear structural elements and assemblages; constraints and releases. Prereq: COI. 3 u.

CE 206 Energy Methods in Civil Engineering. Principle of virtual work; methods of weighted residuals; variational principles; energy principles; applications to linear and nonlinear problems. Prereq: ES 230/COI. 3 u.


CE 212 Applied Hydrology. Basic hydrologic principles; hydrograph analysis. Modern hydrologic techniques applicable to problems in water power, water supply, irrigation and flood control. Prereq: ES 15. 3 u.


CE 214 Groundwater Development. Groundwater movement, storage and exploration, basic principles of groundwater flow and aquifer testing; well design, construction, production tests and maintenance, groundwater recharge and runoff; development and management of aquifers. Prereq: CE 110/COI. 3 u.

CE 215 Water Resources Planning. Concepts in water resources planning; water inventories, use and control; water conservation measures and legislation; single-purpose and multi-purpose project planning; economic and financial analysis. Prereq: CE 112/COI. 3 u.

CE 216 Theory of Plasticity. Mathematical theory of plasticity; plastic stress-strain laws; yield functions and associated flow rules; applications to problems in flexure and torsion; plane plastic flow. Prereq: ES 201, 230. 3 u.

CE 217 Hydraulic Design. Hydraulic structures, gravity structures, reinforced concrete structures, earth structures, various forces acting on hydraulic structures, economic consideration, open channel. Prereq: CE 111/COI. 3 u.

CE 219 Hydraulic Measurements. Principles of design and operation of instruments for the measurement of pressure, velocity, discharged and related fluid flow characteristics. Prereq: ES 15/equiv. 4 h (1 class, 3 lab) 2 u.

CE 220 Soil Erosion and Sedimentation. Erosion control structures; sediment transport, stable channel design; desilting and diversion structures. Prereq: ES 15. 2 u.

CE 222 Advanced Concrete Technology. Structure of concrete; engineering properties of concrete; behavior of fresh and hardened concrete; materials and processes for special concrete; recent advances in concrete technology. Prereq: COI. 3 u.

CE 225 Advanced Construction Engineering. Problems of the construction industry, including organization, financing, bonding and insurance problems. Analysis and possible improvement of present-day techniques and equipment employed in heavy and building construction. Prereq: CE 124/equiv. 3 u.
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CE 226 Structural Dynamics. Response of structural components to transient loads and foundation excitation; single- and multi-degree-of-freedom systems; viscous and proportional damping; modal method; response spectra; introduction to wave propagation in solids. Prereq: ES 21/COI. 3 u.

CE 236 Environmental Benefits and Costs in Civil Engineering Projects. Analysis of environmental benefits and costs of alternative schemes and technologies for development projects in civil engineering. Prereq: COI. 3 u.

CE 240 Transportation Systems Analysis and Planning. Elements and features of transport systems, technological and operational characteristics of various modes of transportation; tools for transport system analysis; land use/transport interaction; forecast of transport demand; principles of planning, design, operation, maintenance and management. Prereq: COI. 3 u.


CE 242 Traffic Engineering and Management. Traffic regulation, control, and traffic signal systems; accidents and their prevention; parking and terminal problems. Coreq: CE 246. 3 u.

CE 243 Highway Engineering. Route location. Advanced geometric design of roads, highway intersections and interchanges. Design of pavement and road facilities. Highway capacity analysis. Traffic control. Prereq: CE 240, 249. 5 h (2 class, 3 lab) 3 u.


CE 245 Mass Transit Engineering. Design and operation of mass transit systems including vehicle, track, station and terminal, and control system design. Analysis of technological, operating and performance characteristics of mass transit systems including capacity, cost, level of service and efficiency. Prereq: CE 240, 249. 3 u.

CE 246 Transportation and Traffic Surveys. Different surveys required to provide information for transportation planning and engineering; methods of conducting surveys; analysis and presentation of survey results. Prereq: CE 21/equiv, COI. 3 u.

CE 247 Transportation Economics and Evaluation. Concepts and principles of transportation economic analysis; transportation costs and benefits; user and non-user consequences, needs studies, finance and taxation; methods of evaluation of plans and projects and cost-effectiveness. Prereq: COI. 3 u.

CE 248 Traffic Flow Theory and Analysis. Traffic flow theories applied to intersections, road links, and terminals; queueing tools used in traffic flow analysis; applications to real life situations; analysis and forecasts of congestion. Prereq: CE 21/equiv, 246. 3 u.

CE 249 Planning and Design of Transportation Facilities. Location, layout and design of different transport facilities; passenger and cargo handling facilities, pedestrian facilities. Prereq: COI. 3 u.

CE 250 Pre-Stressed Concrete. Principles and methods in pre-stressed concrete construction; ultimate strength design; time-dependent variables; long-time deflections; load factors. Prereq: CE 153/equiv. 3 u.

CE 251 Structural Safety and Reliability. Concepts and methods of probabilistic structural mechanics; statistical consideration of loads and structure resistances; engineering significance of statistical extremes; factors of safety; reliability against wind and earthquake forces. Prereq: CE 21/equiv. 3 u.

CE 252 Design of Metal Structures. Theories of behavior of structural metal components; interpretation of codes and specifications in relation to theory and experimental results; buckling of metal elements; special problems in metal connections. Prereq: CE 153/equiv. 3 u.

CE 253 Design of Reinforced Concrete Structures. Ultimate strength and behavior of reinforced concrete; structural components, recent developments in concrete technology; review of current research; design specifications. Prereq: CE 153/equiv. 3 u.
CE 255 Theory of Plates and Shells. Fundamental theories of bending and buckling of plates; flat slab floor systems; folded plate structural elements, thin--walled members; theory of shells applied to tanks, shell roofs, hipped plates, stability problems. Prereq: ES 21, CE 153/equiv. 3 u.

CE 256 Structural Design for Dynamic Effects. Response of structural assemblies to transient loads and foundation excitation; inelastic structural systems; dynamic loading from blasts and earthquakes; criteria for blast and earthquake-resistant designs; non-proportional damping. Prereq: CE 259/COI. 3 u.

CE 257 Discrete Methods of Structural Analysis. Discrete formulation of structural problems; idealization of solid media and structures as lumped-parameter and finite element systems; substructure analyses; mixed structural systems; non-linearity in structures; structure-medium interaction phenomena. Prereq: CE 201/equiv. 3 u.

CE 258 Plastic Structural Analysis and Design. Behavior of steel beyond the elastic range; concept of the plastic hinge in forming collapse configurations; analysis of collapse mechanisms, requirements for stability; incremental collapse, optimum design. Prereq: CE 151/ equiv. 3 u.

CE 259 Earthquake Engineering. Concepts of plate tectonics, elastic rebound and fault movements; measures of earthquake size; geological evaluation; seismological evaluation; construction over active faults; soil dynamics and site response; structure response; structural design and detailing; retrofit of existing structures. Prereq: CE 226/COI. 3 u.

CE 260 Soil and Rock Testing. Field and laboratory test of soils and rocks; developments in testing methods. Prereq: CE 162/equiv. 7 h (1 class, 6 lab) 3 u.


CE 262 Foundation Engineering. Design and construction aspects of structural foundation systems; soil-rock structure interactions; case studies. Prereq: CE 264/COI. 3 u.

CE 263 Soil and Rock Dynamics. Dynamic characteristics of earth materials; wave phenomena in soil and rock masses; analysis and design of substructures and earth structures for dynamic loads. Prereq: ES 230; CE 226, 261. 3 u.


CE 268 Critical State Soil Mechanics. Engineering models and soil mechanics; elasticity; plasticity and yielding of soils; elastic-plastic stress-strain models for soils; critical states; strength of soils; stress-dilatancy models; triaxial tests; stress paths; cam-clay model; application of elastic-plastic models. Prereq: CE260, 261. 3 u.

CE 269 Ground Improvement Techniques. Problematic soils; stability analysis; ground settlements; mechanical modification and densification of soils; granular piles; preloading; vertical drains; dewatering and ground water control; chemical stabilization; soil reinforcement; tiebacks and ground anchors; underpinning; case studies. Prereq: CE 261. 3 u.

CE 270 Fundamental Coastal Hydrodynamics. Linear wave theory; engineering wave properties; tides; waves in shallow water; wave refraction; diffraction; combined refraction-diffraction; reflection; shoaling; wave breaking; wave forces on fixed structures; coastal numerical models. Prereq: ES 15/ equiv. course in fluid mechanics; Coreq: ES 201. 3 u.

CE 273 Coastal Sediment Transport. Beach morphology; mechanics of sediment transport; sediment movement due to oscillatory flow; sediment transport rate; models of coastal sediment transport; shoreline change models; cross-shore sediment transport; longshore sediment transport; beach evolution due to coastal structures. Prereq: CE 270. 3 u.
CE 291 Bridge Design. Historical development; types of bridges; methods of analysis and design; specifications for highway and railroad bridges; recent developments. Prereq; CE 252/COI; CE 253/COI. 3 u.

CE 296 Seminar. 1 u.; maximum of 3 u.

CE 297 Special Topics. 3 u.; may be taken twice; topics to be indicated for record purposes.

CE 298 Special Problems. Prereq; COA and approval of the faculty member who will supervise the study. 3 u.; may be taken twice, topics to be indicated for record purposes.

CE 300 Thesis. 6 u.

CE 301 Environmental Impact Assessment in Civil Engineering Projects. Prediction and assessment of impacts on the environment of projects in the field of structural, geotechnical, water resources, transportation and construction engineering. Prereq: COI. 3 u

CE 304 Probabilistic Method in Civil Engineering. Concepts and methods of probability and statistics; probabilistic modeling; statistical decision theory; risk analysis; reliability analysis; probabilistic-based design; Markov and queuing models; Monte Carlo simulation; applications in civil engineering. Prereq: COI. 3 u.

CE 306 Finite Element Methods in Civil Engineering I. Modeling; formulation and numerical solutions to linear problems using finite element method. Prereq: ES 201, 204. 3 u.


CE 308 Mechanics of Fracture and Fatigue. Elastic stresses at a crack; energy and stress intensity criteria for crack growth; effect of plastic zone at the crack; fracture testing; fatigue characterization by stress-life and strain-life; damage index; crack propagation; fail safe and safe life analysis. Prereq: ES 230/COI. 3 u.

CE 311 River Mechanics and Sediment Transport Modeling. Overview of river mechanics; erosion and sedimentation; one-and-two dimensional flow; unsteady open channel flow equations; velocity profiles; mechanics of sediment-laden flows; incipient motion; bedforms; bedload; suspended load and total load; mathematical modeling of river and reservoir sedimentation. Prereq: COI. 3 u.

CE 313 Stochastic Techniques in Water Resources. Time series analysis; spatial analysis; applications of stochastic techniques to water resource systems. Prereq: COI. 3 u.

CE 315 Mathematical Modeling of Water Resources Systems. Modeling concepts and approaches; methods of solutions; applications to watershed hydrology; river; lake and estuarine flow hydraulics; and groundwater flow. Prereq: COI. 3 u.

CE 316 Optimization and Simulation of Water Resources Systems. Concepts and models of water resources systems; simulation and optimization models; application to watersheds, rivers, lakes, reservoir, groundwater aquifer and conjunctive use of surface and groundwater resources; simulation and optimization techniques incorporating risk and uncertainty. Prereq: COI. 3 u.

CE 318 Groundwater Flow and Contaminant Transport. Basic concepts and mechanisms of groundwater flow and contaminant transport; derivation of general groundwater flow equation; methods of solutions of groundwater flow equation; mass transport in saturated groundwater zone, derivation of advection dispersion equations; transformation; attenuation or retardation mechanisms; methods of solution of mass transport equations; mass transport in the unsaturated zone; groundwater remediation measures. Prereq: COI. 3 u.


CE 340 Advanced Transportation Systems Analysis and Planning. Disaggregate models in transportation; fuzzy logic; advanced tools in planning including geographic information system (GIS) applications. Prereq: CE 240. 3 u.

CE 341 Advanced Traffic Flow Theory and Analysis. Traffic theories applied to highways and intersections; macroscopic and microscopic analyses of traffic flow-hydrodynamic analogies; gap acceptance; car following. Prereq: CE 248. 3 u.
CE 342 Advanced Traffic Engineering and Management. Application of computer simulation, expert systems and intelligent transportation systems (ITS) for solving and evaluating traffic problems. Prereq: CE 242. 5 h (2 lec, 3 lab) 3 u.

CE 350 Advanced Structural Analysis. Material and geometric nonlinear problems; stability analysis; nonlinear analysis and numerical techniques. Prereq: CE 250. 3 u.

CE 351 Random Structural Vibrations. Probability distributions for maxima and extreme values; stationary and ergodic random processes; excitation and response autocorrelation functions; spectral density functions; response characteristics of lightly-damped, linear, narrow-band systems; stochastic response of linear system with multiple degrees of freedom; extreme response of nonlinear systems. Prereq: CE 251, 256, 304. 3 u.

CE 352 Advanced Design of Metal Structures. Design of continuous beams, plate girders, composite steel and concrete members, steel plates and shells; braced and unbraced frames. Prereq: CE 252/COI. 3 u.

CE 353 Advanced Design of Reinforced Concrete Structures. Members subject to bi-axial bending and axial load; slenderness effects on beam-columns; seismic design provisions; design for torsion; two-way slabs. Prereq: CE 253/COI. 3 u.

CE 356 Advanced Structural Dynamics. Methods of structural dynamics for discretized and continuous systems in free and forced vibration; formulation and solution of partial differential equation of motion; potential and kinetic energy methods; mode-superposition; Rayleigh quotient; numerical solution to the eigenvalue problem; direct integration methods; frequency domain analysis; introduction to nonlinear dynamics. Prereq: CE 256. 3 u.

CE 358 Wind Engineering. Concepts of atmospheric boundary layer; extreme wind climatology; wind tunnel; bluff-body aerodynamics; aeroelastic phenomena; along-wind response and across-wind response; pressures on low rise structures; vibrations of high-rise and long-span structures; prevention of windinduced discomfort in and around structures. Prereq: CE 256/COI. 3 u.

CE 360 Geotechnical Testing and Instrumentation. Site investigation techniques; soil and rock sampling; laboratory testing for strength and compressibility; triaxial tests; odometer tests; in-situ testing techniques; laboratory and field instrumentation; case studies. Prereq: CE 260, 261. 7 h (1 lec, 6 lab) 3 u.

CE 361 Advanced Soil Mechanics. Stress and strain in soils; effective stress principles; continuum mechanics; flow through porous media; consolidation theory; stability analysis; seepage analysis; analytical and numerical methods. Prereq: CE 360, ES 201, 204. 3 u.

CE 397 Special Topics in Civil Engineering. Prereq: COI. 3 u.

CE 398 Special Problems in Civil Engineering. Prereq: COI. 3 u.

CE 400 PhD Dissertation. 12 u.