

## 교과목 개요

### ▣ Undergraduate Program

#### **CE101 Introduction to Sustainable Environmental and Energy Engineering**

This class is designed to stimulate scientific curiosity and societal responsibility of freshmen in relation to current environmental and energy issues, such as global warming, depletion of fossil fuel, water management and treatment, water pollution/solid waste treatment and reclamation. Solution approaches will be introduced and discussed.

#### **CE201 Mechanics of Materials**

This course covers properties of structural members. These properties include tension, compression and shear forces, strain energy, stress-strain relationship, axially loaded member, torsional members, shear force and bending moment on beams, stresses in beams, stress and strain analysis, principal stress and strain, yielding condition of materials, and deflection of beams

#### **CE202 Structural Mechanics**

This course covers types of structures, forces and stresses, analysis of beams, trusses, frames and grid structures to obtain reactions, stresses, and displacements. It also covers the behavior of structures under moving loads, influence line, behaviors of columns and application of energy methods to structural mechanics.

#### **CE203 Fluid Mechanics & Hydraulics**

This course is to discuss about physico-chemical principles of environmental engineering processes including process principles, theories, equations and applications. This course will give emphasis on process principles rather than unit operations. This is because an understanding of process mechanisms and control variables is fundamental for the effective application of unit operations to accomplish specific treatment objectives.

#### **CE206 Introduction to Sustainable Engineering**

This course provides methodologies on transportation systems analysis and operations. It covers fundamental theories on transportation systems, transportation system analysis techniques, and methodologies to manage and operate transportation systems in efficient and safe ways.

#### **CE208 IT in Construction Engineering**

This course focuses on basic IT technologies for civil engineers. Various smart sensors and programming techniques will be studied and the students can apply this knowledge to structural health monitoring and control. The mobile robot control using microprocessors will be briefly introduced, and each student will assemble a wheeled mobile robot to have navigation and control experiments.

#### **CE210 Evolution of Space and Structures**

This course is to understand evolution of spaces and structures in civil, architecture and urban. It is the four-module sequence divided by the important historical events with a particular emphasis on technological innovation. It is structured as dialogue between historical and theoretical frameworks that affect our understanding of built environment. We will explore projects ranged from the classic to the contemporary periods.

#### **CE230 Soil Mechanics and Laboratory I**

This course deals with origin of soils, structures, fundamental properties and related problems. It is also taught to explain flow of water in ground, 1-dimensional compression, effective stress, and stress distribution in soils.

#### **CE231 Soil Mechanics and Laboratory II**

This course deals with fundamental geotechnical problems and their solutions. It contains consolidation, shear strength, lateral earth pressure, slope stability, environmental geotechnology, subsoil exploration, etc.

#### **CE240 Introduction to Architecture and Urbanism**

This course focuses on inspiring students to understand the field of architecture and urbanism. In particular, by exploring history, theory, and design of architecture and urbanism, students can identify significant buildings and urban places in the history and theory, and consider how to improve the quality of the built environment. This course additionally helps students to experience urban and architectural design and studies and to enhance their integrated approaches to sustain our daily place and life.

#### **CE291 Introduction to Geospatial Analysis**

This course introduces concepts and techniques for analyzing spatial, or geographic, data. We will apply a variety of tools to manage, transform, and visualize spatial data, all of which can be loosely categorized as "geographic information systems" (GIS). Students will be able to create maps that illustrate spatial patterns, processes, or statistical findings.

#### **CE303 Structural Dynamics and Lab.**

This course covers fundamental principles and concepts of structural dynamics including free and forced vibration analyses of single-degree-of-freedom (DOF) and two DOF systems, and time and frequency domain solution techniques through lectures and experiments.

#### **CE312 Structural Analysis**

This course is to introduce theory and application of modern structural analysis for statically indeterminate structures and is focused on the followings: (1) stiffness, energy and force methods, with emphasis on the direct stiffness method; (2) equilibrium and compatibility; (3) virtual work; (4) use of matrix operation for structural analysis; (5) modeling of two- and three-dimensional structures; (6) analysis of statically indeterminate truss and frame structures by hand and by computer; (7) solution of statically indeterminate structures by the displacement method of analysis; and (8) verification and interpretation of structural response.

#### **CE314 Design of Reinforced Concrete Structures**

This course introduces design code for concrete structures: design of beams, columns, slabs, and footings.

#### **CE315 Reinforced Concrete and Laboratory**

This course covers properties of concrete material, flexural behavior of beam, axial and flexural behavior of column, shear and torsion, bond and anchorage, deflection and crack. Laboratory work is also performed.

#### **CE331 Rock Mechanics**

This course covers the origin of rock and its classification, the characteristics and behaviors of rock mass, the shear strength of rock mass, the laboratory and field testing methods of rock, the state of stress, rock mass classification, the mechanical behavior of rock mass, and the applications of rock mechanics to engineering problems.

#### **CE332 Foundation Engineering**

This course deals with site investigation, in situ testing, bearing capacity and settlement of shallow foundation; the topics of site improvement, earth pressure theory, retaining wall, pile and pier foundations are also treated.

#### **CE333 Soil Dynamics**

This course deals with elastic wave propagation (bar, infinite media, half space), site investigation using elastic waves, dynamic soil properties, nondestructive test and evaluation, vibration criteria, monitoring and control, machine foundations, seismic design code, earthquake ground motion, liquefaction.

#### **CE350 Introduction to Transportation Systems Engineering**

This course provides general introduction to Transportation Systems Engineering. It covers transportation planning and policy making process, Transportation system analysis and design, Traffic theories and Safety.

#### **CE351 Civil and Environmental Engineering Data Analysis**

Application of the concepts and methods of probability theory and statistical inference to Civil & Environmental Engineering (CEE) problems and data; graphical data analysis and sampling; elements of set theory; elements of probability theory; random variables and expectation; simulation; statistical inference; data mining. Applications to a wide range of CEE problems involving real data will be developed, using both pre-existing and student-prepared MATLAB codes. The course also introduces the student the analysis of uncertainty analysis in different domains of CEE.

#### **CE352 Signals and Systems for Construction IT**

This course deals with signals and systems in continuous and discrete time. The main focus is on Linear time-invariant (LTI) system. Mathematical methods for understanding and analysing signals and systems are introduced with engineering applications.

**CE355 Introduction to Smart Transportation Systems**

Smart Transportation Systems refers to the Systems for sustainable and efficient Transportation systems using less energy and cost. This course provides the ways of planning, developing, and managing Transportation Systems for the life cycle of the transportation infra-structure systems.

**CE371 Environmental Science and Engineering**

The goal of this course is to understand global environmental/energy problems using basic scientific knowledge (prerequisite), to identify their impacts on engineered and natural eco-systems, and finally to develop students' ability to solve the environmental/energy problems potentially encountered near future.

**CE372 Water and Wastewater Engineering**

This course deals with distribution systems of water, collection systems of wastewater, properties of pumps, and physical, chemical, biological unit processes.

**CE373 Hydrology**

The water cycle and its component processes are introduced. The topic of surface runoff water is discussed in depth. All of the topics are relevant to provide an engineering basis for quantity management of rivers and lakes.

**CE376 Basic Principles of Groundwater Engineering**

This course provides an introduction to the analysis of subsurface groundwater flow and the contaminant transport. The course will focus on the concepts of hydrogeology relevant to environmental engineers including Darcy's Law, aquifer flow equations, well hydraulics, contaminant transport, and capture zone analysis

**CE393 Construction Management and Project Scheduling**

This course is designed to introduce students various aspects of project management. Upon successful completion of this course students should be able to understand: how a project is formed and conducted/ major planning and scheduling methods/ major estimating and cost control methods/ important roles of project management/ other issues related to project management.

**CE410 Cyber Physical Systems & Smart Spaces**

This course introduces Cyber Physical System(CPS) technologies - data communication, IoT, context awareness, cloud computing, big data analysis, interactive multimedia & multi-modal interfaces with smart city associated systems plus group project for actual CPS system making.

**CE412 Design of Steel Structures**

This course covers material properties and behavior of steel, understanding and comparison of design codes for steel structures, design of beam-to-column joints, design of steel members such as beams and columns, and fundamental theories for buckling of structural members.

**CE413 Prestressed Concrete**

This course covers basic concepts of prestressed concrete, material properties, flexural design, shear and torsion, bond and anchorage, anchorage zone design, partial loss of prestress force, composite beams, analysis of continuous beams and deflections.

**CE416 Elementary Structural Engineering & Laboratory**

The objective of this course is (1) to have students learn and appreciate the significances of structural engineering theories through hands-on experiments, (2) to learn various sensing and measurement techniques, and (3) to improve their presentation skills. The course will be composed of a series of lectures followed by weekly experiments, student presentations, and a final term project.

**CE421 Energy Geotechnology and Geology**

The objectives of this course are (1) to introduce the student to petroleum geology and energy geotechnology for resource and energy production; (2) to familiarize the student with the physics and transport phenomena in porous media; and (3) to provide the student with a firm foundation for the continuation to more theoretical and applied aspects in energy resource production and storage.

**CE432 Energy Geotechnology**

The objectives of this course is to introduce the student to basic knowledge related to exploration, production and storage of energy resources, such as conventional oil and gas, unconventional hydrocarbons, geothermal energy, and

nuclear wastes; to provide fundamental understanding of thermal, hydrological, mechanical behaviors of porous media; and to provide the student with a firm foundation for the continuation to research in geophysics, geomechanics, and energy geotechnology.

**CE435 Geotechnical Engineering Design I**

This course is aimed at performing geotechnical engineering design for practice, based on soil mechanics and foundation engineering principles, such as site characterization and geotechnical properties, consolidation and settlement, seepage and its control, retaining wall, slope stability, and foundation.

**CE440 Urban Planning**

Urban competitiveness under the trend of global urbanization with the fact that urban population occupied over 90% of the total Korean is major issue in terms of academic aspect and national agenda. This course is designed to study the basic knowledges on urban studies such as urban planning theories, techniques and related regulations.

**CE441 Urban and Architectural Design Studio**

This course focuses on inspiring students to understand the field of architecture and urbanism. In particular, by exploring history, theory, and design of architecture and urbanism, students can identify significant buildings and urban places in the history and theory, and consider how to improve the quality of the built environment. This course additionally helps students to experience urban and architect

**CE445 Sustainable Architectural Design**

This course introduces the students in this integral design approach for a Sustainable Urban/ Architecture Design. First, this course is to discuss and explore the awareness of the environmental issues and the historical effort how Architecture and Urban planning meaningfully researches. And , each student will have a concept for the sustainable approach and develop his/her design project at the technical and aesthetic levels.

**CE452 Advanced Transportation System Engineering**

Focus on transportation analytics utilizing various statistical learning models and applying them to transportation big data. Topics include, but not limited to, descriptive statistics, various supervised learning models such as linear model and tree generation. A short discussion on unsupervised learning is discussed at the end of semester.

**CE471 Water Resources and Groundwater Engineering**

To ensure the availability of adequate water supplies in the future, efficient water management is necessary. Management in this sense should include engineering activities and economic, social, political and environmental considerations together. This course should present all these relevant materials in a unified framework, emphasizing the planning and design of systems to manage water resources including groundwater.

**CE473 Physical Processes in Environmental Engineering**

Physical processes in environmental engineering have been used in a lot of applications by utilizing gravity, electricity, surface tension, etc. as the driving forces to remove and/or treat environmental contaminants. This course will offer basic theories as well as practical applications of various physical processes in environmental treatment processes.

**CE474 Smart-Eco Policy and Management**

This course is to provide a set of operational contributions to environmental policy analysis and to discuss about multidimensional approach to environmental and resource management problems. Also, emphasis is given to an integration of different fields which normally play a role in environmental policy analysis: economics, physics, regional science, ecology and social and political science.

**CE481 Special Topics in Civil and Environmental Engineering**

This course is offered for undergraduate students to deliver recent issues on civil and environmental engineering practices. For the relevant issues, subtitles can be given to emphasize the related issues.

**CE482 Short Course in Civil and Environmental Engineering I****CE483 Short Course in Civil and Environmental Engineering II****CE484 Special Topics in Civil and Environmental Engineering I**

Recent advances in civil and environmental engineering are lectured. Details on the topics are available at the beginning of each semester. The goal of this course is to introduce recent research and results in the selected area

of research.

**CE485 Special Topics in Civil and Environmental Engineering II**

This course deals with selected special subjects that it is hard to cover the other courses. This course covers new topics of interest in civil and environmental engineering. The course content is specifically designed by the instructor.

**CE490 B.S. Thesis Research**

**CE495 Individual Study**

**CE496 Seminar**

This course is composed of invited lectures from experts in the field of civil and environmental engineering.

**▣ Graduate Program**

**CE501 Advanced Mechanics of Materials**

The lecture provides fundamental concepts for modeling the macroscopic behavior of solid and fluid given that each of them is a continuous medium. Specific contents include tensor analysis, Eulerian and Lagrangian description, stress, strain, constitutive equations, Hookean solid and Newtonian fluid.

**CE502 Advanced Soil Mechanics**

This course deals with fundamental characteristics of soil behavior, shear strength, consolidation theory for drainage-installed soft ground and some field performance of embankment on soft clay. Several analytical methods of consolidation theories are explained and their results are discussed. The analytical results are compared with those obtained in the field measurements.

**CE504 Advanced Environmental Chemistry**

The goal of this course is to understand the concept of advanced chemistry and develop the ability of application for the identification of chemical phenomena occurred in natural and engineered environments. The course will provide basic knowledge to properly conduct important environmental researches and to fully understand environmental problems in hazardous waste treatment, wastewater treatment, and contaminated soil and groundwater remediation.

**CE505 Applied Mathematics**

This course introduces fundamental mathematical techniques related to applied mechanics, dealing with vectors, tensors, analysis of vector fields, matrix and linear equations, eigen-value problems, linear spaces, linear operations, functionals, variational and approximate methods, complex variables, conformal mapping, Fourier transformation and Laplace transformation, etc.

**CE514 Advanced Structural Dynamics**

This course covers single- and multiple-degree-of-freedom vibration problems, normal mode superposition methods, modal analysis and matrix formulation of vibration problems, natural frequency and mode, principle of D'Alembert, Newton's second law, principle of virtual work, and Lagrange's equations for systems of particles and for rigid bodies.

**CE515 Mechanics of Composite Materials**

This course introduces materials and their applications, anisotropic elasticity, failure theories, hydrothermal behavior, 3-D stress analysis of laminates, hybrid composites and advanced topics, design principles for bracings and members subjected to torsion, design of composite beams, columns, and beam-columns, behavior and design of shear, and semi-rigid and moment connections.

**CE516 Finite Element Analysis**

The course covers the fundamental theory of Finite Element Methods and its application in structural engineering. It includes shape functions, stiffness matrix, direct methods, variational method, weighted residual method, assembly of stiffness matrix and solution of equilibrium equations, static and dynamic analysis, linear and non-linear problems, and computer programming.

**CE518 Reliability Analysis of Structures**

This course introduces probability and statistics, extreme value distributions, probability of failure, reliability, reliability index, failure modes of structures, reliability of structures, system reliability, Monte-Carlo simulation, and load and resistance factor design.

**CE519 Bridge Engineering & Design**

This course covers design code, influence line, load, the Rahmen bridge, the slab bridge, and the PS concrete box-girder bridge.

**CE520 Introduction to Smart Structure Technology**

This course offers an introduction to the emerging technologies in smart structure systems and the application of smart structures technologies to civil infra-structures. Contents of lectures include the concepts of smart materials and their properties, advanced sensors, signal / information processing, structural health monitoring method, control theories (passive / semiactive / active) and their applications to civil infra-structures. Students will gain understanding

of the state-of-the-art smart structures technologies through lectures and laboratory tests and have chances to work on their application to civil infra-structures.

#### **CE530 Geophysical Exploration for Energy Resources**

The course objectives are to introduce the student about near-surface geophysical methods for energy exploration and environmental applications; to deliver basic understanding of geophysics of porous media; and to familiarize the student with some measurement techniques of geophysical methods via laboratory tests and with some signal processing techniques, such as time and frequency domain analyses, forward and inverse problems, and tomography.

#### **CE531 Geotechnical Experiments**

This course deals with transducer characteristics, calibration, direct shear test, triaxial test (UU, CU, and CD), permeability test (fixed wall, flexible wall), consolidation test, free-free resonant column test, small-strain triaxial test, impact echo test, vibration monitoring, and cross-hole tests.

#### **CE532 Rock Engineering with IT**

This course covers an introduction to stress analysis, the physical properties of rock, underground stresses, laboratory and field instrumentation, model studies, rock mass properties, excavation and blasting, and the discussion of a number of rock mechanics field applications associated with civil, mining, and petroleum engineering, and geoscience.

#### **CE533 Site Investigation and IT based Monitoring**

This course deals with site investigation plan, boring method, SPT, CPT, DMT, Field Vane Test, PMT, refraction survey, cross-hole test, SASW test and also includes in situ monitoring plan, equipments and case studies.

#### **CE534 Analysis of Soil Behavior by IT**

This course focuses on the critical state theory. Based on the theory, some models to describe the soil behavior are discussed. Especially, Cam-Clay model and its design properties are deeply explained. Upper and lower bound theories are also dealt with to calculate the bearing capacity of foundations.

#### **CE536 Design of Smart-City Underground Structures**

Highly skilled engineers from various disciplines are required to achieve an economical tunnel and underground space design that can be safely constructed while meeting environmental requirements. This course covers design and construction methods, an understanding of excavation methods, and conditions of underground space construction essential to good designs of smart city underground structures.

#### **CE539 Earth Retaining Structures for Smart-City**

This course includes earth pressure theory, site investigation, designs of retaining wall, sheetpile wall, braced excavation, diaphragm wall, reinforced earth, and soil nailing. The performance monitoring of earth structures will also be covered.

#### **CE541 Sustainable Infrastructure Systems Engineering**

This course provides methodologies on planning, operating and maintaining urban infrastructure systems. It covers optimization methodologies for individual facilities considering full life cycle, maintenance and management methodologies for city infrastructure systems, and finally for optimized green city implementation.

#### **CE545 Data, Decision and System Analysis**

Advanced course in data-driven decision making related to applications of artificial intelligence techniques to transportation system analysis. Topics included but not limited to bayesian statistics, computational statistics, machine learning and DNNs. Both manned and unmanned mobility cases will be explored. Students are encouraged to bring their own case studies.

#### **CE547 Transportation System analysis and Operations**

This course provides methodologies on transportation systems analysis and operations. It covers fundamental theories on transportation systems, transportation system analysis techniques, and methodologies to manage and operate transportation systems in efficient and safe ways.

#### **CE551 Soft Computing Techniques for Engineering Design**

This course deals with various numerical and combinatorial optimization techniques for solving engineering and structural design problems. This course puts emphasis on the most recent AI (artificial intelligence) and soft computing-based optimization techniques such as neural networks, deep learning, fuzzy logic, and evolutionary computation (EC) as well as classical optimization techniques.

#### **CE553 IT for Smart City**

This course deals with basic IT technologies which will be used in Smart City. Various communication systems, especially wireless communication techniques for smart sensor network, will be studied and the technologies which can implement location based service among the USN-based services will be also dealt with.

#### **CE554 Mechanical Design of Civil Robot**

This course deals with mechanical design methodologies of various robots. Robot manipulator, Legged robot, wheeled robot, micro/nano robot will be studied in the view point of mechanical design.

#### **CE558 Introduction to Civil Robotics**

This course is targeted to familiarize graduate students with applied robotics other than EECs and ME. This course helps students understand general civil robotics issues and apply robot techniques to civil engineering application area. Specifically the students can understand fundamental principles of robotics by simulating their application world with robotics simulation tool.

#### **CE560 Smart and Green Environmental Design**

This course explores innovative principles and techniques for Environmental Pollutions, Energy Problems, Water and Waste Treatments, Transportation Problems, CO2 Emission to make smart and green urban infrastructure and other forms of built environment.

#### **CE563 Modeling Autonomous Driving and Intelligent Transportation Systems**

This course deals with the modeling of autonomous driving and Intelligent Transportation Systems which is one of the core components of Smart City. It includes traffic theory, ITS architecture, simulation modeling and control. Especially, it seeks to combine modern AI techniques with transportation technologies for traffic prediction, signal control, and autonomous vehicles control.

#### **CE564 Technology and the Smart City**

This course introduces students to the concept of the "smart city", the relationship between urban development and technological development, and a wide range of interfaces between the physical and informational layers of the city. This course will challenge students to critically examine how smart cities are proposed, designed, and implemented. Students will learn to analyze the social, economic, political, and practical problems unique to cities that technologies are meant to address, and why some attempts succeed while others fail.

#### **CE571 Environmental Engineering Laboratory**

This course deals with theories and experiments related to the manufacture of physical, chemical and biological reactors, operational and experimental plans, scale-up problems, and analysis / application of environmental data.

#### **CE572 Environmental Microbiology and Biotechnology**

This course will offer lecture series on environmental microbiology and its application in environmental biotechnology. The main topics dealt in the class will include microbial physiology and ecology and their application in biotechnical practices including bioremediation and bioenergy production. This course will also provide an introduction to state-of-art techniques used in microbiology research, including qPCR, next-generation sequencing, metagenomics, and single-cell technology.

#### **CE573 Advanced Membrane-based Water Treatment**

This course will offer the advanced knowledge on the fabrication, separation theory, and state-of-art applications of membranes related on water and wastewater treatment processes.

#### **CE577 Integrated Water Resources Management**

This study is designed to review fundamental principles of water and environmental management and their applications for sustainable development. Natural processes combined with human activities in watersheds determine

the inherent quality of the management. That is, by responding to changing social, economic and environmental needs or impacts, one can gradually achieve better and sustainable water resources management. In this context, this course is organized to provide principles of both physical systems and human-related systems in a integrated framework.

#### **CE579 Hazardous and Industrial Waste Treatment**

This course consists of clean technologies, reduction technologies, intermediate and final waste disposal technologies in hazardous and industrial waste management. It also includes purification technologies for contaminated soil and groundwater. Term projects are required for all students.

#### **CE580 Structural Pattern Recognition for Statistical Health Monitoring**

Structural Health Monitoring(SHM) is a process that evaluates and assesses the safety and integrity of a structural system based on measured data. This course deals with various structural pattern recognition tools required for SHM.

#### **CE582 Environmental Electrochemistry**

The goal of this class is to present electrochemistry as an important field of environmental engineering that can be applied to dealing with serious environmental problems. This course will start with basic fundamentals of electrochemistry, and then cover key analysis techniques, understanding of electrochemical devices and finally important topics in the area of environmental electrochemistry.

#### **CE590 Elastoplastic Analysis and Design of Structural Systems**

This course provides fundamental knowledge of continuum mechanics and plastic modeling of engineering problems. Various kinds of plastic models are explained, and the implementation will be discussed in the form of variational method.

#### **CE596 Special Topics in Structural Engineering Design for U-Space**

Learn basic design principles, theories and methodologies related to U-space structures through discussions with invited speakers.

#### **CE597 Special Topics in Geotechnical Engineering Design for U-Space**

This course deals with methods to solve geotechnical engineering problems related with U-Eco city construction. Especially, the students learn U-Geotechnical design concepts to prevent any natural or manmade disasters caused by failures of geotechnical structures. This course is possible to give a subtitle to deal with methods to mingle geotechnical problems with U-concepts.

#### **CE598 Special Topics in Environmental Engineering Design for U-Space**

In this lecture, students can analyze the cause of local and global environmental problems of 21 century and learn how to develop and design environmental technologies which can provide basic understanding on the solutions to protect and overcome natural and environmental disasters due to the local and global environmental problems.

#### **CE599 Special Topics in U-Space Construction IT Design**

This course is targeted to familiarize CEE graduate students with applied robotics other than EECS and ME. This course helps students understand general civil robotics issues and apply robot techniques to civil engineering application area. Specifically the students can understand fundamental principles of robotics, HRI (Human-Robot Interaction), and problem solving techniques using them.

#### **CE611 Inelastic Analysis of Reinforced Concrete Structures**

This course covers creep and shrinkage in RC structures, thermal effects and analysis of RC structures, limit design and yield line theory, application of fracture mechanics to concrete structures, and nonlinear analysis by Finite Element Method.

#### **CE614 Stability of Structures for Smart-City**

To reserve the stability of structural members subject to axial load together with lateral loads, the structural behavior of each member is analyzed and, in advance, the corresponding critical load to be resisted is calculated. Various structural members such as beam-column, rigid frame, ring and arched members are considered, and the exact understanding for the background of design codes is achieved on the basis of structural stability.

#### **CE617 Earthquake Engineering**

This course covers the mechanism of earthquake occurrence, tectonic plate theory, engineering characteristics of earthquake, seismic hazard analysis, earthquake ground motion, response spectra, dynamic responses of structures subjected to earthquake, nonlinear structural responses, frequency domain analysis, preventive design of structures (buildings, bridges, and underground structures), soil-structure interaction, probabilistic earthquake risk analysis, and earthquake mitigation and management.

#### **CE619 Vibration Control of Structures**

This course introduces the theory of structural passive and active control, applications to vibration isolation, damping treatment, and dynamic absorbers, application to tall buildings, cable-stayed bridges, and tension structures, design of classical feedback control systems for civil structures, and simulation studies using customized computer software.

#### **CE623 Fracture Mechanics of Concrete**

Quasibrittle materials and structures are full of cracks. Their failure involves stable growth of large cracking zones and the formation of large fractures before the maximum load is reached. This course reviews the mechanism and analytical techniques for the cracking, which includes linear elastic fracture mechanics and size effect on quasibrittle fracture.

#### **CE631 Advanced Numerical Soil Mechanics**

This course discusses the applicable numerical methods to geotechnical problems. The geotechnical problems that are dealt with in this course are seepage, consolidation, displacements of retaining and underground structures, excavations, embankment, etc. The numerical analysis methods such as the finite difference method (FDM), the finite element method (FEM), the boundary element method (BEM), and the discrete element method (DEM) are used to solve the geotechnical problems.

#### **CE633 Advanced Soil Dynamics**

This course deals with elastic wave propagation (bar, infinite media, half space), site investigation using elastic waves, dynamic soil properties, nondestructive test and evaluation, vibration criteria, monitoring and control, and machine foundations.

#### **CE636 Geotechnical Earthquake Engineering & Design**

This course deals with performance based seismic design code, earthquake ground motion, soil liquefaction, evaluation of dynamic soil properties, seismic design of various geotechnical structures.

#### **CE637 Theory of Geophysics**

This course covers the principles of elastic and electromagnetic waves, applied to geophysical characterization, to understand the interaction of soil and water, conduction and diffusion, elastic wave in soil, electromagnetic wave in soil, wave velocity and attenuation, elastic and electromagnetic wave measurements in laboratory, and their applications.

#### **CE672 Smart City Environmental Unit Processes**

This course is to discuss about physico-chemical principles of environmental engineering processes including process principles, theories, equations and applications. This course will give emphasis on process principles rather than unit operations. This is because an understanding of process mechanisms and control variables is fundamental for the effective application of unit operations to accomplish specific treatment objectives.

#### **CE781 Advanced Topics in Civil and Environmental Engineering**

This course aims to deliver special topics in the field of civil and environmental engineering.

#### **CE960 M.S. Thesis Research**

#### **CE966 Seminar (M.S.)**

#### **CE980 Ph.D. Thesis Research**

#### **CE986 Seminar (Ph.D.)**