(It will be applied from 2016-2017 Fall)
İZMİR INSTITUTE OF TECHNOLOGY
GRADUATE SCHOOL OF ENGINEERING AND SCIENCES
DEPARTMENT OF CIVIL ENGINEERING
CURRICULUM OF THE M.S. PROGRAM IN CIVIL ENGINEERING

Program Core Courses		**Credit**
CE 500	M.S. Thesis	(0-1)NC
CE 598	**M.Sc. Research Seminar***	**(0-2)NC**
CE 8XX	Special Studies	(8-0)NC

Total credit (min.) : 21
Number of courses with credit (min.): 7

***All M.S. students must register CE 598 M.Sc. Research Seminar course until the beginning of their 4th semester.**

In addition to the program core courses, students must choose one of the following research areas in the course registration period of their first semester and complete its area core and area elective course requirements.

Area 1: Structural Mechanics

Area Core Courses		**Credit**
CE 502	Advanced Numerical Methods in Engineering	(3-0)3
CE 573	Structural Dynamics	(3-0)3
CE 513	Theory of Elasticity	(3-0)3
Area Elective Courses		
CE 501	Advanced Analytical Methods in Engineering	(3-0)3
CE 512	Finite Element Method	(3-0)3
CE 514	Theory of Plates and Shells	(3-0)3
CE 515	Theory of Matrix Structural Analysis	(3-0)3
CE 516	Advanced Structural Analysis	(3-0)3
CE 518	Earthquake Engineering	(3-0)3
	Pre. Undergraduate "CE423 Introduction to Structural Dynamics (Technical Elective) (3-0)3" course or Consent of the Instructor	
CE 519	Advanced Design of Steel Structures	(3-0)3
CE 520	Prestressed Concrete Members	(3-0)3
CE 521	Reinforced Concrete Members	(3-0)3
CE 529	**Soil Dynamics**	**(3-0)3**
CE 535	Advanced Structural Dynamics	(3-0)3
CE 536	Reinforced Concrete Structures	(3-0)3
	Pre.CE "518 Earthquake Engineering (3-0)3" or Consent of the Instructor	
CE 537	Bridge Design	(3-0)3
CE 539	Advanced Mechanics of Materials	(3-0)3
CE 540	Stability of Structures	(3-0)3
CE 541	Structural Reliability	(3-0)3
CE 550	**Geotechnical Earthquake Engineering**	**(3-0)3**
CE 551	Optimization and Design	(3-0)3
CE 571	Artificial Intelligence Methods in Engineering	(3-0)3
CE 572	Structural Control	(3-0)3
CE 574	Structural Retrofit of Existing Structures	(3-0)3
CE 575	Nonlinear Finite Elements for Solid Mechanics	(3-0)3
	Pre. "CE512 Finite Element Method (3-0)3"	
CE 576	Mechanics of Reinforced Concrete	(3-0)3
	Pre. "CE512 Finite Element Method (3-0)3" and "CE 513 Theory of Elasticity (3-0)3" or consent of instructor	

Area 1 Course Requirements: Area core courses must be completed and at least three of the elective courses should be taken from the area elective course list.

(It will be applied from 2016-2017 Fall)

Area 2: Geotechnics

Area Core Courses		**Credit**
CE 501	Advanced Analytical Methods in Engineering	(3-0)3
CE 527	Advanced Soil Mechanics I	(3-0)3
CE 544	Stability of Soils	(3-0)3

Area Elective Courses		
CE 502	Advanced Numerical Methods in Engineering	(3-0)3
CE 512	Finite Element Method	(3-0)3
CE 518	Earthquake Engineering Pre. Undergraduate "CE423 Introduction to Structural Dynamics (Technical Elective) (3-0)3" course or Consent of the Instructor	(3-0)3
CE 526	Advanced Soil Mechanics II	(3-0)3
CE 528	Evaluation of Soil Behavior	(3-0)3
CE 529	**Soil Dynamics**	**(3-0)3**
CE 530	Engineering Properties of Soils	(3-0)3
CE 535	Advanced Structural Dynamics	(3-0)3
CE 539	Advanced Mechanics of Materials	(3-0)3
CE 542	Tunnel Design and Construction Methods	(3-0)3
CE 543	Advanced Foundation Design and Construction	(3-0)3
CE 545	Ground Improvement Methods	(3-0)3
CE 549	Embankment Dams	(3-0)3
CE 550	**Geotechnical Earthquake Engineering**	**(3-0)3**
CE 554	Soil and Groundwater Remediation Technologies	(3-0)3
CE 555	Environmental Geotechnics	(3-0)3
CE 558	Environmental Impact Assessment in Engineering	(3-0)3
CE 561	Digital Mapping for GIS	(3-0)3
CE 571	Artificial Intelligence Methods in Engineering	(3-0)3
CE 573	Structural Dynamics	(3-0)3

Area 2 Course Requirements: Area core courses must be completed and at least three of the elective courses should be taken from the area elective course list.

Area 3: Hydromechanics and Water Resources

Area Core Courses		**Credit**
CE 501	Advanced Analytical Methods in Engineering	(3-0)3
CE 505	Open Channel Hydraulics	(3-0)3
CE 508	Advanced Mechanics of Fluids	(3-0)3

Area Elective Courses		
CE 504	Advanced Watershed Hydrology	(3-0)3
CE 506	Hydrologic Time Series Analysis	(3-0)3
CE 507	Design of Hydraulic Structures	(3-0)3
CE 509	Transport Processes in Surface Flows	(3-0)3
CE 510	Sediment Transport	(3-0)3
CE 511	Coastal Engineering	(3-0)3
CE 512	Finite Element Method	(3-0)3
CE 531	Environmental Quality Modeling	(3-0)3
CE 532	Groundwater Hydrology and Pollutant Transport	(3-0)3
CE 533	Pollution Control in Sea Environment	(3-0)3
CE 534	Non-Point Source Pollution	(3-0)3
CE 538	Water Resources System Engineering	(3-0)3

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CE 549	Embankment Dams	(3-0)3
CE 554	Soil and Groundwater Remediation Technologies	(3-0)3
CE 556	Wastewater Reclamation and Reuse	(3-0)3
CE 557	Techniques of Groundwater Monitoring	(3-0)3
CE 558	Environmental Impact Assessment in Engineering	(3-0)3
CE 561	Digital Mapping for GIS	(3-0)3
CE 571	Artificial Intelligence Methods in Engineering	(3-0)3

Area 3 Course Requirements: Area core courses must be completed and at least two of the elective courses should be taken from the area elective course list.

Area 4: Materials of Construction

Area Core Courses **Credit**

CE 517	Advanced Concrete Technology	(3-0)3
CE 562	Construction Materials Testing	(3-0)3
CE 563	Admixtures for Concrete	(3-0)3
	Pre. Undergraduate "CE244 Materials of Construction (3-2)4" course or Consent of the Instructor	

Area Elective Courses

CE 501	Advanced Analytical Methods in Engineering	(3-0)3
CE 513	Theory of Elasticity	(3-0)3
CE 522	Highways and Airport Pavement Design	(3-0)3
CE 551	Optimization and Design	(3-0)3
CE 564	Durability of Construction Materials	(3-0)3
	Pre. Undergraduate "CE244 Materials of Construction (3-2)4" course or Consent of the Instructor	
CE 565	Special Concretes	(3-0)3
	Pre. Undergraduate "CE244 Materials of Construction (3-2)4" course or Consent of the Instructor	
CE 571	Artificial Intelligence Methods in Engineering	(3-0)3
CHE 513	Techniques For Microstructural Characterization of Materials	(3-0)3
CHE 517	Corrosion	(3-0)3
CHE 519	Cement Chemistry	(3-0)3
CHE 524	Composite Materials	(3-0)3
CHE 537	Microporous and Mesoporous Materials	(3-0)3
CHE 555	Statistics for the Analysis of Measurement Systems and Experimental Data	(3-0)3
EE 545	Image Processing	(3-0)3
ME 501	Microstructure and Mechanical Properties	(3-0)3
ME 507	Analytical Techniques in Materials Science	(3-0)3
ME 510	Fracture Mechanics	(3-0)3
ME 513	Advanced Composite Techniques	(3-0)3
ME 524	Experimental Design	(3-0)3
MSE 501	Fundamentals of Materials Science and Engineering	(3-0)3
MSE 502	Physical Properties of Materials	(3-0)3
MSE 513	Materials Microstructure	(3-0)3
RES 551	Deterioration and Conservation of Historical Building Materials	(3-0)3
RES 552	Laboratory Research Techniques of Historical Building Materials	(3-2)4
RES 556	Characteristics of Lime Mortars and Plasters Used in Historical Buildings	(3-0)3
FE 534	Multivariate Statistical Analysis for Engineers	(3-0)3

Area 4 Course Requirements: Area core courses must be completed and at least two of the elective courses should be taken from the area elective course list.

(It will be applied from 2016-2017 Fall)
Area 5: Transportation

Area Core Courses		**Credit**
CE 502	Advanced Numerical Methods in Engineering	(3-0)3
CE 523	Theory of Traffic Flow	(3-0)3
CE 530	Engineering Properties of Soils	(3-0)3

Area Elective Courses		
CE 511	Coastal Engineering	(3-0)3
CE 522	Highways and Airport Pavement Design	(3-0)3
CE 524	Urban Traffic Management and Control	(3-0)3
CE 525	Airport Engineering	(3-0)3
CE 527	Advanced Soil Mechanics I	(3-0)3
CE 537	Bridge Design	(3-0)3
CE 542	Tunnel Design and Construction Methods	(3-0)3
CE 544	Stability of Soils	(3-0)3
CE 545	Ground Improvement Methods	(3-0)3
CE 551	Optimization and Design	(3-0)3
CE 558	Environmental Impact Assessment in Engineering	(3-0)3
CE 561	Digital Mapping for GIS	(3-0)3
CE 562	Construction Materials Testing	(3-0)3
CE 571	Artificial Intelligence Methods in Engineering	(3-0)3
CP527	Static Optimization & Decision Analysis	(4-0)4
CP535	Public Transportation Systems Operations	(2-2)3
CP571	GIS And Remote Sensing Based Disaster Management Studies	(3-0)3
EE531	Probability And Random Processes	(3-0)3

Area 5 Course Requirements: Area core courses must be completed and at least two of the elective courses should be taken from the area elective course list.

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Civil Engineering Courses		**Credit**	
CE 501	Advanced Analytical Methods in Engineering	(3-0)3	
CE 502	Advanced Numerical Methods in Engineering	(3-0)3	
CE 504	Advanced Watershed Hydrology	(3-0)3	
CE 505	Open Channel Hydraulics	(3-0)3	
CE 506	Hydrologic Time Series Analysis	(3-0)3	
CE 507	Design of Hydraulic Structures	(3-0)3	
CE 508	Advanced Mechanics of Fluids	(3-0)3	
CE 509	Transport Processes in Surface Flows	(3-0)3	
CE 510	Sediment Transport	(3-0)3	
CE 511	Coastal Engineering	(3-0)3	
CE 512	Finite Element Method	(3-0)3	
CE 513	Theory of Elasticity	(3-0)3	
CE 514	Theory of Plates and Shells	(3-0)3	
CE 515	Theory of Matrix Structural Analysis	(3-0)3	
CE 516	Advanced Structural Analysis	(3-0)3	
CE 517	Advanced Concrete Technology	(3-0)3	
CE 518	Earthquake Engineering	(3-0)3	**Pre. Undergraduate "CE423 Introduction To Structural Dynamics (Technical Elective) (3-0)3" course or Consent of the Instructor**
CE 519	Advanced Design of Steel Structures	(3-0)3	
CE 520	Prestressed Concrete Members	(3-0)3	
CE 521	Reinforced Concrete Members	(3-0)3	
CE 522	Highways and Airport Pavement Design	(3-0)3	
CE 523	Theory of Traffic Flow	(3-0)3	
CE 524	Urban Traffic Management and Control	(3-0)3	
CE 525	Airport Engineering	(3-0)3	
CE 526	Advanced Soil Mechanics II	(3-0)3	
CE 527	Advanced Soil Mechanics I	(3-0)3	
CE 528	Evaluation of Soil Behavior	(3-0)3	
CE 529	**Soil Dynamics**	**(3-0)3**	
CE 530	Engineering Properties of Soils	(3-0)3	
CE 531	Environmental Quality Modeling	(3-0)3	
CE 532	Groundwater Hydrology and Pollutant Transport	(3-0)3	
CE 533	Pollution Control in Sea Environment	(3-0)3	
CE 534	Non-Point Source Pollution	(3-0)3	
CE 535	Advanced Structural Dynamics	(3-0)3	
CE 536	Reinforced Concrete Structures	(3-0)3	**Pre.CE 518 "Earthquake Engineering (3-0)3 or Consent of the Instructor**
CE 537	Bridge Design	(3-0)3	
CE 538	Water Resources System Engineering	(3-0)3	
CE 539	Advanced Mechanics of Materials	(3-0)3	
CE 540	Stability of Structures	(3-0)3	
CE 541	Structural Reliability	(3-0)3	
CE 542	Tunnel Design and Construction Methods	(3-0)3	
CE 543	Advanced Foundation Design and Construction	(3-0)3	
CE 544	Stability of Soils	(3-0)3	
CE 545	Ground Improvement Methods	(3-0)3	
CE 549	Embankment Dams	(3-0)3	
CE 550	**Geotechnical Earthquake Engineering**	**(3-0)3**	
CE 551	Optimization and Design	(3-0)3	
CE 553	Air Quality Management	(3-0)3	
CE 554	Soil and Groundwater Remediation Technologies	(3-0)3	
CE 555	Environmental Geotechnics	(3-0)3	

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CE 556	Wastewater Reclamation and Reuse	(3-0)3	
CE 557	Techniques of Groundwater Monitoring	(3-0)3	
CE 558	Environmental Impact Assessment in Engineering	(3-0)3	
CE 561	Digital Mapping for GIS	(3-0)3	
CE 562	Construction Materials Testing	(3-0)3	
CE 563	Admixtures for Concrete	(3-0)3	**Pre. Undergraduate "CE244 Materials of Construction (3-2)4" course or Consent of the Instructor**
CE 564	Durability of Construction Materials	(3-0)3	**Pre. Undergraduate "CE244 Materials of Construction (3-2)4" course or Consent of the Instructor**
CE 565	Special Concretes	(3-0)3	**Pre. Undergraduate "CE244 Materials of Construction (3-2)4" course or Consent of the Instructor**
CE 571	Artificial Intelligence Methods in Engineering	(3-0)3	
CE 572	Structural Control	(3-0)3	
CE 573	Structural Dynamics	(3-0)3	
CE 574	Structural Retrofit of Existing Structures	(3-0)3	
CE 575	Nonlinear Finite Elements for Solid Mechanics	(3-0)3	**Pre.CE512"Finite Element Method(3-0)3"**
CE 576	Mechanics of Reinforced Concrete	(3-0)3	**Pre.CE512"Finite Element Method(3-0)3, CE 513 "Theory of Elasticity (3-0)3" or consent of instructor**
CE 580	Special Topics in Civil Engineering	(3-0)3	
CE 590	Technical Report Writing	(0-2)NC	

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COURSE DESCRIPTIONS

CE 500 M.S. Thesis (0-1)NC
A research topic which can be experimental and/or theoretical has to be pursued. It should fulfill the requirements set by the İzmir Institute of Technology Graduate Program.

CE 501 Advanced Analytical Methods in Engineering (3-0)3
Heat flow. The method of separation of variables. Fourier series. Nonlinear partial differential equations. The method of characteristics. Fourier and Lap lace transforms.

CE 502 Advanced Numerical Methods in Engineering (3-0)3
Numerical methods for solving non-linear equations. Finite difference method for solving elliptic, parabolic and hyperbolic equations in one and two dimensions. Irregular regions. Derivative boundary conditions. Rayleigh-Ritz method. Finite element method for solving elliptic, parabolic and hyperbolic equations in two dimensions.

CE 504 Advanced Watershed Hydrology (3-0)3
Analysis and mathematical modeling of hydrologic processes taking place in a watershed. Precipitation analysis. Overland flows. Saturated and unsaturated flow processes.

CE 505 Open Channel Hydraulics (3-0)3
Energy and momentum principles. St. Venant equations. Flood routing. Flow in channels of nonlinear alignment and nonprismatic section. Flow over spillways. Energy dissipation. Method of characteristics. Explicit and implicit methods. Stability of numerical scheme.

CE 506 Hydrologic Time Series Analysis (3-0)3
Application of statistical methods for analysis and modeling of hydrologic series. Statistical simulation and prediction of hydrologic sequences using time series methodology.

CE 507 Design of Hydraulic Structures (3-0)3
Hydraulic design criteria and problems of reservoirs, spillways, outlet works, river training, and regulation, transition structures, conduit systems, and hydraulic machinery. Application of multiple purpose designs involving flood control, water supply, irrigation, recreation, drainage and navigation. Coastal engineering, estuaries, and harbors.

CE 508 Advanced Mechanics of Fluids (3-0)3
Rotational flows. Navier-Stokes equations and solutions for laminar flow. Boundary layer equations and solution techniques. Nature of turbulence. Reynolds equations. Introduction to turbulence modeling.

CE 509 Transport Processes in Surface Flows (3-0)3
Density-stratified two-layer systems in lakes and channels, with applications to mixed-layer growth, oil-spill containment, salinity intrusions. Advection-diffusion modeling in channels, including analytical solutions to steady unsteady, one or two dimensional problems. Mechanics of diffusional transport, including turbulence in channels and longitudinal shear dispersion. Near-field analysis of discharges, including similarity analysis of jets and plumes.

CE 510 Sediment Transport (3-0)3
Sediment properties and mechanics of sediment transport. Threshold of movement. Riverbed load and suspended load theories. Regime theory and stable channel design. River diversion problems. Erosion. Geomorphological and water quality aspects.

(It will be applied from 2016-2017 Fall)

CE 511 Coastal Engineering (3-0)3

An introduction to coastal engineering with emphasis on the interaction between oceanic dynamic processes (waves, currents, and tides) and coastal regions (beaches, harbors, structures, and estuaries) and on the engineering approaches necessary to prevent adverse effects caused by this interaction.

CE 512 Finite Element Method (3-0)3

Approximate analysis procedures. Galerkin and Stationary Principle method. Construction of approximate solutions by the finite element method. Applications to one- and two-dimensional problems in engineering. Introduction to time dependent, non-linear and three-dimensional problems.

CE 513 Theory of Elasticity (3-0)3

Fundamental equations of elasticity. Plane stress and plane strain. Flexure and torsion of bars of various shapes. Introduction to variational and approximate methods.

CE 514 Theory of Plates and Shells (3-0)3

Kirchhoff plate bending theory, analytical solution of circular plates, classical solution of rectangular plates by Navier and Levy methods, and by numerical techniques of Rayleigh-Ritz, finite difference and finite element methods. Analytical solution of shells of revolution based on membrane and bending theories, and numerical solution by the finite element method.

CE 515 Theory of Matrix Structural Analysis (3-0)3

Analysis of discrete member systems. Displacement and force methods. Energy formulation. Direct stiffness method. Large displacements and stability. Static and kinematic condensation. Substructure analysis.

CE 516 Advanced Structural Analysis (3-0)3

Energy theorems and extremum principles in structural mechanics. Spatial methods for deflection computations. Equilibrium formulation of structural problems. Transformation matrices for force and displacement systems.

CE 517 Advanced Concrete Technology (3-0)3

Types of cements, their composition and potential usage. Compressive, tensile, fatigue and impact strengths. Mechanical behavior of concrete, shrinkage and volume changes, creep, durability, thermal, and acoustic properties.

CE 518 Earthquake Engineering (3-0)3

Earthquake characteristics. Seismic loads. Elastic and inelastic response. Analysis and design of buildings for earthquakes.

Pre. Undergraduate "CE423 Introduction To Structural Dynamics (Technical Elective) (3-0)3" course or Consent of the Instructor

CE 519 Advanced Design of Steel Structures (3-0)3

Design considerations for steel column and frame buckling. Steel-plate girder design. Steel-concrete composite design. Design of connections.

CE 520 Prestressed Concrete Members. (3-0)3

Theory, advantages, and limitations. Various systems of prestressing. Composite construction. Continuous span theory.

CE 521 Reinforced Concrete Members (3-0)3

Behavior of reinforced concrete members. Critical review of specifications. Limit states. Anchorage and development of reinforcement. Shear. Torsion.

(It will be applied from 2016-2017 Fall)

CE 522 Highways and Airport Pavement Design (3-0)3

Theories of stresses and strains in flexible and rigid pavement systems. Wheel and axle configurations. Traffic anlysis. Soil classification. Compaction of soils. Frost action and subsurface drainage. Design of bases and sub-bases. Structural design of flexible and rigid pavements. Design of joints and reinforcing steel for concrete pavements. Maintenance and rehabilitation. Cost analysis. Pavement selection criteria.

CE 523 Theory of Traffic Flow (3-0)3

Study and evaluation of various qualitative and quantitative descriptions of the complex phenomenon of traffic flow. The conceptual and mathematical models considered are statistical relationships, car-flowing analogy, queuing theory, traffic network analyses, computing machine simulation studies, mathematical experiments and distribution function theories.

CE 524 Urban Traffic Management and Control (3-0)3

Nature of urban vehicular traffic congestion. Roadway capacity. Intersection design and traffic signal operations. Freeway operations and management. Corridor control. Traffic stream models. Traffic delay models. Traffic forecasting.

CE 525 Airport Engineering (3-0)3

Air traffic control and aircraft characteristics related to airport design. Estimates of aeronautical demand. Airport site selection. Airport configuration and airport capacity. Geometric design of landing area. Planning and development of terminal area. Airport lighting. Design of heliports. Airport drainage.

CE 526 Advanced Soil Mechanics II (3-0)3

Concept of failure. Failure theories. Mohr-Coulomb failure criterion. Shear resistance between soil particles. Shear testing methods. Pore pressure parameters. Shear strength of cohesionless and cohesive soils. Stability analysis types.

CE 527 Advanced Soil Mechanics I (3-0)3

The nature of soils. Stresses within a soil mass. States of stress. Mohr circle. Stress paths. Effective stress principle. Stress-strain relationships. Concepts from elastic theory. Capillarity in soil. Swelling and shrinkage. Consolidation theory. Settlement in sands.

CE 528 Evaluation of Soil Behavior (3-0)3

The microscopic nature of soil. Application of physico-chemical principles for the behavior of clay soils. Clay minorology. Properties of double layer. Soil fabric and structure. Soil formation and characteristics of soil deposits. Soil behavior with respect to soil structure and composition.

CE 529 Soil Dynamics (3-0)3

Foundation vibrations. Design of foundations for machinery. Stress strain behavior of soil during transient and repeated loadings. Effects of earthquakes upon structures. Amplification by a soil layer. Effect of foundation upon building response. Dynamics of lumped systems as applied to problems in soil dynamics.

CE 530 Engineering Properties of Soils (3-0)3

Engineering properties of soils, including compaction phenomena, with emphasis on strength and compressibility. Measurement of shear strength, compressibility and permeability in the laboratory and field. Experiments to examine the nature and validity of strength and compressibility theories and their application to stability and settlement analysis.

CE 531 Environmental Quality Modelling (3-0)3

Quality requirements for beneficial uses of water. Hydrologic cycle of quality. Hydromechanics in relation to quality of surface and groundwaters. Transport and fate of waterborne pollutants. Predictive methods. Mathematical models of water quality. Sensitivity and reliability as analytical and predictive tools.

(It will be applied from 2016-2017 Fall)

CE 532 Groundwater Hydrology and Pollutant Transport (3-0)3

Fundamental concepts in groundwater hydrology and pollution occurrence. Groundwater flow in different aquifers. Flow nets. Well hydraulics. Chemical properties of groundwater sources and effects of contamination. Numerical modeling of groundwater flow and chemical transport.

CE 533 Pollution Control in Sea Environment (3-0)3

Hydrodynamic/oceanographic characteristics. Waste dispersion characteristics. Turbulent diffusion/dispersion theories. Dilution and mixing of pollutants and heated discharges from sea outfalls. Jet and plume mixing. Turbulent buoyant jets in uniform and stratified environments.

CE 534 Non-Point Source Pollution (3-0)3

Surface flows and erosion processes. Contaminant transport by surface flows. Salt transport and chemical transport in saturated and unsaturated zone. Hydrochemical models.

CE 535 Advanced Structural Dynamics (3-0)3

Analysis of structures subjected to earthquake, wind, and blast loading. Distributed, consistent and lumped mass techniques. Development of a computer program for complex structures. Response spectrum analysis. Frequency and time domain analysis.

CE 536 Reinforced Concrete Structures (3-0)3

Behavior of reinforced concrete structures, with emphasis on ductility and detailing of frames, slabs, and braced (shearwall) structures. Detailing for seismic loads.
Pre.CE518 "Earthquake Engineering (3-0)3" or Consent of the Instructor

CE 537 Bridge Design (3-0)3

Design and construction of steel and concrete bridges, bridge history and aesthetics. Design methods, bridge loads and distribution factors. Concrete slab bridges. Steel bridges. Prestressed concrete bridges. Substructure design.

CE 538 Water Resources System Engineering (3-0)3

Planning, design and management of water resources systems. Application of deterministic and stochastic optimization techniques. Water allocation, capacity expansion, and design and operation of reservoir systems. Surface water and groundwater management

CE 539 Advanced Mechanics of Materials (3-0)3

Theories of stress and strain. Stress-strain-temperature relations. Inelastic material behavior and yield criteria. Energy methods. Torsion. unsymmetrical bending. Shear center.

CE 540 Stability of Structures (3-0)3

A treatment of stability as it relates to actual behavior and design. Columns, frames, beams and beam-columns are considered, elastic and inelastic theories are compared with actual behavior and design requirements for bracing systems are presented.

CE 541 Structural Reliability (3-0)3

This course aims to present theoretical and design developments in the growing field of structural reliability. Fundamental concepts related to structural reliability, safety measures, load model, resistance models, system reliability, optimum safety levels, and optimization of design codes.

CE 542 Tunnel Design and Construction Methods (3-0)3

Design and construction of various Tunnels for different purposes, underground stations, ventilation, fire safety, other related issues.

CE 543 Advanced Foundation Design and Construction (3-0)3

Design and construction of shallow and deep foundations for various structures. Slab-on-grade foundations, individual combined footings, continuous footings(piled/non-piled),mat foundations, bored piles, prefabricated and cast-in-situ displacement piles, piles for retaining or anchorages purposes.

(It will be applied from 2016-2017 Fall)

CE 544 Stability of Soils (3-0)3

Design and construction of slopes: Embankments for various purposes/retaining walls/deep excavations with shoring/anchorages/tie-backs/bored piles/reinforced concrete prefabricate or cast-in-situ displacement piles effect and control of ground water table.

CE 545 Ground Improvement Methods (3-0)3

Ground improvement methods for various soils, advantages-disadvantages. Among studied methods: Vibro-compection or replacement, preloading, ground freezing, grouting (cement/Chemical or gel), displacement piles, compacted fills, mat foundations.

CE 549 Embankment Dams (3-0)3

Types of dams, eartfill and rockfill dams, typical sections and their elements, basic design principles, static-dynamic dam's slope stability analyses (for long term after construction/rapid drawdown case/short term-during construction), piping/seepage control, filter design, earth cores, cracking control in earth dams in tranverse-longitudinal directions, monitoring, QC/QA during construction.

CE 550 Geotechnical Earthquake Engineering (3-0)3

The basic concepts of seismology, earthquakes, and strong ground motions are introduced. Basic principles of wave propagation are used to develop procedures for ground response analysis and to provide insight into such important problems as liquefaction, seismic design of slope stability, and retaining structures.

CE 551 Optimization and Design (3-0)3

Introduction to operation research. Optimization techniques such as linear programming, dynamic programming, and non-linear programming. Application in water quality, air quality and waste management.

CE 553 Air Quality Management (3-0)3

Mobile, fugitive, and point source of air pollution. Attendant effects on materials, plants, and humans. Use of mathematical dispersion models. Meteorological fundamentals and atmospheric transport. Concepts of ambient air quality control strategies including urban planning and transportation considerations.

CE 554 Soil and Groundwater Remediation Technologies (3-0)3

Physical, chemical and biological treatment. Fixation. Nitrification. Steam and air stripping. Groundwater pollution prevention. Management of groundwater quality.

CE 555 Environmental Geotechnics (3-0)3

Non-Hazardous and hazardous solid and liquid wastes and their disposal, waste control systems, design-construction of municipal landfills/covers/liners, vertical vapor barriers, cut-off walls, mine tailings dams, decommissioning of mines/petrol stations and contaminated (brown) lands, remediation of contaminated soils and groundwater against various contaminants (including bioremediation against petroleum contamination), continuous QC/QA by related parties, field-laboratory testing, monitoring during contruction and operation, analysis of results, interpretation and reporting.

CE 556 Wastewater Reclamation and Reuse (3-0)3

Wastewater reuse in water resources planning. Wastewater reuse practice in agricultural and irrigation industry. Groundwater recharge. Recreational and environmental uses. Portable water reuse. Selection of reclamation technologies. Assessment of health risks and health risk mitigation.

CE 557 Techniques of Groundwater Monitoring (3-0)3

The topic includes properties and classification of tracer, selection tracers in field experiments, isotope tracer, basic concept of nuclear physics, environmental isotopes (Tritium, oxygen 18, deuterium, carbon-14), tracers of artificial isotopes, colorful tracers, biological tracer, chemical tracers, determination of porosity and permeability for tracer test, site investigation, and application.

(It will be applied from 2016-2017 Fall)

CE 558 Environmental Impact Assessment in Engineering (3-0)3
The topic includes the concept of environment, geochemistry of environment, determination suitable area for city constructions, affects of natural hazards on environment, geothermal energy and its environment effects, mining and its environment effects, protection of natural heritage, assessment environmental issues in surface and groundwater basin scale, vulnerability maps to contamination, the concept of protection basin, Environmental Impact Assessment (EIA) procedure in international level, rapid impact assessment methods, environmental law.

CE 561 Digital Mapping for GIS (3-0)3
Review of computer aided drafting (CAD). Digital mapping. Land information systems (LIS). Geographic information systems (GIS). Fundamentals of data capture and conversion. Map projections., reference coordinate systems and transformations. 2D/3D digitizing systems, image rectification/registration, and error propagation. Review of data structures for GIS. Digital elevation models.

CE 562 Construction Materials Testing (3-0)3
Tests on fresh and hardened cementitious materials, aggregate, binders, bricks, wood and steel; analysis and presentation of test data; mechanical testing; common testing apparatus; static tension and compression tests; non-destructive tests for concrete; instructions for laboratory work.

CE 563 Admixtures for Concrete (3-0)3
The definition and classification of the concrete admixtures, the precautions in their use, air-entraining admixtures, chemical admixtures, mineral admixtures, and miscellaneous admixtures will be examined. For each admixture type, its properties, standard specifications, classification (if any), usage purpose, beneficial and detrimental effects on the fresh and hardened concrete properties, mechanism of action, and advantages and disadvantages when compared to other admixtures will be discussed.
Pre. Undergraduate "CE244 Materials of Construction (3-2)4" course or Consent of the Instructor

CE 564 Durability of Construction Materials (3-0)3
The definition and importance of durability, the basic properties of main building materials (concrete, ferrous and non-ferrous metals, wood, building stones, clay bricks, gypsum, lime, plastics), factors affecting the durability, the mechanisms of decaying, precautions to increase the durability, durable material selection, durability tests and economic aspects of the durability.
Pre. Undergraduate "CE244 Materials of Construction (3-2)4" course or Consent of the Instructor

CE 565 Special Concretes (3-0)3
The design and characteristics of lightweight concrete, heavyweight concrete, self-consolidating concrete, fiber-reinforced concrete, mass concrete, concrete in hot weather, concrete in cold weather, high strength concrete, high performance concrete, roller compacted concrete, shrinkage compensating concrete.
Pre. Undergraduate "CE244 Materials of Construction (3-2)4" course or Consent of the Instructor

CE 571 Artificial Intelligence Methods in Engineering (3-0)3
The aim of this course is to give the fundamental concepts of artificial neural networks, fuzzy logic, neuro-fuzzy systems and genetic algorithms. The course shall also cover the material related to the applications of these intelligence methods in solving different engineering problems.

CE 572 Structural Control (3-0)3
Control application to structural systems is best utilized with a good understanding of the fundamentals of complex system response. This is established by giving a background in analysis and algebra as needed. Controllability and observability properties will be evaluated, and by using feedback and optimal control methods, structures will be bound to react against earthquakes and wind effects, based on their designs. At the end of this course, students will be able to design optimal controllers and feedback observers for various structural systems.

(It will be applied from 2016-2017 Fall)

CE 573 Structural Dynamics (3-0)3

Dynamic equilibrium equations. Single and multi degree of systems under harmonic, periodic and general dynamic loading. Energy methods. Modal analysis. Earthquake response of structures.

CE 574 Structural Retrofit of Existing Structures (3-0)3

Objectives of structural retrofit process. Assessment of as-built condition. Decision about the target performance of the structure. Assessment of possible demands from the structure. Retrofit methods and selection of the suitable approach to the specific structure. Selection and application of analysis procedures. Application details of some specific retrofit strategies at member and structural level.

CE 575 Nonlinear Finite Element Analysis (3-0)3

Sources of nonlinearities, review of continuum mechanics, spatial discretization and nonlinear FE formulations with 2D and 3D bulk elements, solution of nonlinear system of equations, formulation and solution of small strain plasticity in nonlinear FE context.
Pre.CE512"Finite Element Method(3-0)3"

CE 576 Mechanics of Reinforced Concrete (3-0)3

The course consists of two main parts. In the first part, mechanical properties of concrete and reinforcement are reviewed and theories of elasticity and plasticity, as applied to reinforced concrete, are examined. Constitutive models and failure criteria are introduced. Modified Compression Field Theory and rotating, smeared crack models are studied. Effects of prestrains, offsets and crack slip distortions are discussed in conjunction with the Disturbed Stress Field Model. The second part of the course focuses on the implementation of the models and theories studied in the first part to the nonlinear finite element analysis. Finite element formulations for reinforced concrete are derived. Several case studies are conducted using a nonlinear finite element analysis computer program.
Pre.CE512"Finite Element Method(3-0)3, CE 513 "Theory of Elasticity (3-0)3" or consent of Instructor

CE 580 Special Topics in Civil Engineering (3-0)3

Directed group study of special topics in (A) Hydraulics and hydrologic engineering; (B) Geotechnical engineering; (C) Structural engineering; (D) Transportation engineering; and (E) Water resources engineering.

CE 590 Technical Report Writing (0-2)NC

Conducting and preparing journal papers, reports and thesis. Methods of research. Procedures for drafting, outlining and revision. Design of layouts. Extensive writing. Practice with journal papers and reports.

CE 598 M.Sc.Research Seminar (0-2)NC

Literature review, design of a research program, analysis and presentation of research results, preparation of a technical paper and publication process, conflict of interest in scientific research, environmental ethics, ethical issues in peer review and publication, research misconduct, responsible authorship, ethics of mentoring, obligation to protect the public, a seminar in relevant research area.

CE 8XX Special Studies (8-0)NC

Graduate students supervised by the same faculty member study advanced topics under the guidance of their advisor.

CHE 513 Techniques for Microstructural Characterization of Materials (3-0)3

Current methods of directly examining the microstructure of materials. Optical microscopy, SEM, field-ion microscopy. TEM. X-ray topography. STEM.

CHE 517 Corrosion (3-0)3

Thermodynamics and kinetics of electrode reactions in aqua-corrosion of metals and alloys forms of corrosion. Various methods of corrosion testing. Methods of corrosion control including alloy selection, water chemistry, design rules, anionic and cathodic protection and coatings. Extension to environmental degradation of ceramics and polymers.

(It will be applied from 2016-2017 Fall)

CHE 519 Cement Chemistry (3-0)3
A review of hydraulic bonding materials. Production and bonding mechanisms of Portland cement. Classification of cement and their application areas. Review of the current research on cement, concrete and concrete composites. Dependence of the mechanical properties on processing, temperature and time

CHE 524 Composite Materials (3-0)3
Behaviour, processing and desing of composite materials, especially fiber composites. Emphasis is on the chemical and physical processes currently employed and expected to guide the future development of the technology.

CHE 537 Microporous and Mesoporous Materials (3-0)3
Characterization (surface area, porosity etc.). Application areas (adsorption and ion exchange). Heat and mass transfer. Diffusion.

CHE 555 Statistics for the Analysis of Measurement Systems and Experimental Data (3-0)3
Analytical Scientists must use a range of statistical tools in their treatment of experimental data as well as in establishing standard operating procedures of the measurement systems they use. Course participants will learn how to develop a valid analytical program for a measurement system along with statitics needed in the laboratory. Hence, statistical procedures that are most likely to be required will be taught including descriptive statistics, probablitiy distributions, hypothesis testing,analysis of variance, calibration, and outlier testing.

EE 531 Probability and Random Processes (3-0)3
Engineering applications of probability theory. Problems on events, independence, random variables and vectors, probability distribution and density functions, expectations, and characteristic functions. Dependence, correlation, and regression; multi-variate Gaussian distribution. Stochastic processes, stationarity, ergodicity, correlation functions, spectral densities, random inputs to linear systems; Gaussian and Poisson processes. Markov Chains and processes. Introduction to estimation theory and Wiener filtering.

EE 545 Image Processing (3-0)3
Properties and analysis tools for multidimensional signal and systems. Image perception and human visual systems. Stochastic models for image representation. Transform techniques and image data compression. Analysis of video images, motion estimation. Image analysis and computer vision. Image reconstruction from projections.

ME 501 Microstructure and Mechanical Properties (3-0)3
Deformation types. Dislocation mechanics. Deformation by slip and twinning. Fracture in common engineering materials; brittle and ductile fractures. Grain size, solute atom and precipitate strengthening mechanisms in metals. Ceramics and their microstructure. Composites' microstructures and mechanical properties.

ME 507 Analytical Techniques in Materials Science (3-0)3
Study of the mechanical, thermomechanical, physical and microstructural characterisation of materials. Materials system include metals, ceramics, polymers, composites and surfaces and interfaces in these systems. Applications to mechanical property characterisation. Fracture and fractography. Surfaces and interfaces. Dynamic mechanical analysis of polymeric materials. Optic and scanning electron microscopy. Polymer molecular structure determination and durability experiments.

(It will be applied from 2016-2017 Fall)

ME 510 Fracture Mechanics (3-0)3

Study of the linear elastic fracture mechanics, stress analysis of cracks, elastic-plastic fracture mechanics, crack growth, fracture mechanisms in metals and non-metals, ductile fracture, cleavage, fracture of plastics, ceramics and composites, fracture toughness testing of metals and non-metals and fatigue crack propagation.

ME 513 Advanced Composite Techniques (3-0)3

Composite material constituents. Microstructure-performance relationships. Strength of long-fiber composites. Thermoelastic behaviour of laminated composites. Short fiber composites. Hybrid composites. Flexible composites. The interface region, interface formation mechanisms, measurement of bonding strength. Strength and toughness of composites. Processing technologies for polymer, metal and ceramic matrix composites and their applications.

ME 524 Experimental Design (1-4)3

Introduction. Basics of statistics. Use of spreadsheets for laboratory calculations. The nature of experimental variation. Using spreadsheets to make charts and graphs. Introduction to ANOVA tables. Using spreadsheets to analyze Latin-square experimental design, Factorial experimental designs, Box-Hunter experimental designs, and Ruggedness designs.

MSE 501 Fundamentals of Materials Science and Engineering (3-0)3

Fundamentals of materials, atomic bonding, crystal structures, non-crystalline structures, defects, diffusion, mechanical properties, microstructure, phase diagrams, heat treatment.

MSE 502 Physical Properties of Materials (3-0)3

Mechanical properties of materials, electrical properties of materials, thermal properties of materials, optical properties of materials, magnetic properties of materials

MSE 513 Materials Microstructure (3-0)3

Crystallography, crystal structures and the effect of symmetry on properties. The structure of amorphous materials. The nature and kinetic of microstructural transformations in materials. Homogenous and heterogeneous nucleation. The defects and dislocations in crystals.

RES 551 Deterioration and Conservation of Historical Building Materials (3-0)3

Properties of historical building materials and the causes of their deterioration processes. Philosophy of material conservation on historical buildings. Modern analysis and remedial techniques of conservation interventions. Discussion of examples related with material conservation.

RES 552 Laboratory Research Techniques of Historical Building Materials (3-2)4

Presentation of laboratory research techniques in the analysis of the historical building materials. Diagnosis of material deterioration, treatment and conservation techniques. Laboratory research related with the materials of the building studied in the restoration project.

RES 556 Characteristics of Lime Mortars and Plasters Used in Historical Buildings (3-0)3

In this course, characteristics of lime mortars and plasters are introduced. Technical and scientific equipment will be used in the laboratory to analyze lime mortars and plasters found in historic buildings.

CP 527 Static Optimization & Decision Analysis (4-0)4

Linear Programing, Mixed Intiger Programing, Constrained and Unconstrain, Mathematical Optimizations, Shortest Path Algorithms, Queueing Models, Decision Analysis.

(It will be applied from 2016-2017 Fall)

CP 535 Public Transportation Systems Operations (2-2)3

Operator types of urban public transportation systems. The modes; surface (land), underground and water. Guided (Right of Way) systems and flexible (tired systems) systems. Their system and operational characteristics. Principles of Route Determination. Demand configuration ; Passenger demand, Fleet size determination, Tariff designation. Signalization, control of the systems, Navigation and Vehicle Tracking. Operations Research in the design of the system. Calculation of the revenues and costs. The subsidizing policy, price optimization and the issues of pricing. Technology determination. Efficiency in the quality servicing equity principles. The place of efficient servicing in urban planning. Other try and error (experimental) approaches in the system design.

CP 571 Gis And Remote Sensing Based Disaster Management Studies (3-0)3

This course is composed of three themes: Hazard Mapping, Risk and Vulnerability Analysis and Evacuation Analysis. To understand these areas: it will be reviewed a range of spatial analytical techniques and their implementation in state of the art GIS software. An important aspect of the course is to gain hands-on experience in applying these techniques using GIS and spatial analytical software to address some research question. The main goal of the class is for you to become familiar with the essential methodological and practical issues that are involved in carrying out sophisticated spatial analyses using GIS and other spatial type software to help you make policy decisions.

This course will be a combination of a lecture and lab course. The course consists of two parts: lecture / discussion and a lab. The lecture/discussion period will cover methodology, theory, concepts and application of statistical and spatial analysis and GIS as well as periodic articles to be discussed. The lab period of the course will introduce students to a variety of tolls to analyze data spatially, including GIS or Geographic Information Systems, Spatial Statistics, Exploratory Spatial Data Analysis (ESDA). Students are encouraged to spend time outside of the normal lab period getting to know the software tolls. Remember, this course is not intended to be cookbook type course to teach students how to press buttons on the GIS, but rather focus on the reason why someone would use spatial methods.

FE 534 Multivariate Statistical Analysis for Engineers (3-0) 3

The course will cover the statistical tools for the analysis of process data. Basics of matrix algebra, statistics and graphical techniques to describe data, normal distribution, test of normality, hypothesis testing will be introduced first. The methods to compare several multivariate population means will be included. Techniques that are used for modeling and monitoring multivariate processes will be covered; linear regression, principal component analysis, factor analysis, discrimination and clustering analysis will be given to model and classify process data, and also to monitor and diagnose the process. Students who want to take this course should be familiar to a software to perform required matrix operations.