CIVIL ENGINEERING (CE)

CE 199. SPECIAL TOPICS. (1-4 Credits)

CE 202. CIVIL ENGINEERING: GEOSPATIAL INFORMATION AND GIS. (3 Credits)
Introductory design principles presented with the use of GIS and geospatial information (remote sensing, GPS, surveying, and aerial photography) for civil engineering problem solving. Introduction to the integration of geospatial data and analysis for decision making and management for site selection, mitigation, change analysis, modeling and assessment. Standard software and custom programming used in course. Students participate in both individual and team projects and presentations. Projects from the area of civil engineering. Lec/lab.
Prerequisites: CE 201 with C or better or CCE 201 with C or better or ENGR 248 with C or better

CE 299. SPECIAL TOPICS. (1-4 Credits)
Graded P/N.
Equivalent to: CE 299H
Attributes: HNRS – Honors Course Designator

CE 301. CE JUNIOR SEMINAR. (1 Credit)
Professional practices of civil engineering.

CE 311. FLUID MECHANICS. (4 Credits)
Fluid properties, fluid statics, fluid motion, conservation of mass, momentum and energy for incompressible fluids, dimensional analysis, civil engineering applications.

CE 313. HYDRAULIC ENGINEERING. (4 Credits)
Analysis of large civil engineering fluid systems including conduit flow, multiple reservoirs, pipe networks, pumps, turbines, open channel flow, and hydraulic structures.
Prerequisites: CE 311 with C or better or CHE 331 with C or better or CHE 331H with C or better

CE 361. SURVEYING THEORY. (4 Credits)
Use of surveying equipment, Gaussian error theory applied to measurements, calculations of position on spherical and plane surfaces, state plane coordinate systems, introduction to global positioning systems.

CE 365. HIGHWAY LOCATION AND DESIGN. (3 Credits)
Curve problems in highway design, including circular, vertical, compound curves and spirals; earth distribution analysis; preliminary office studies; paper location procedures and field layout problems.
Prerequisites: CE 361 with C or better or CEM 263 with C or better or FE 208 with C or better

CE 372. GEOTECHNICAL ENGINEERING I. (4 Credits)
Basic soil mechanics including the identification and classification of soil, principles of compaction and consolidation, flow through porous media, effective stress, and shear strength. Lec/lab.
Prerequisites: ENGR 213 with C or better or ENGR 213H with C or better and (CE 311 (may be taken concurrently) [C] or CEM 311 (may be taken concurrently) [C] or CHE 331 (may be taken concurrently) [C] or CHE 331H (may be taken concurrently) [C])

CE 373. GEOTECHNICAL ENGINEERING II. (4 Credits)
Application of fundamental soil mechanics principles to analyses of slope stability, retaining structures, and foundation support. Lec/rec.
Prerequisites: CE 372 with C or better or FE 315 with C or better

CE 381. STRUCTURAL THEORY I. (4 Credits)
Analysis of statically determinate structures (beams, frames, trusses, arches, and cables). Approximate analysis, influence lines, deflections.
Prerequisites: ENGR 213 with C or better or ENGR 213H with C or better

CE 382. STRUCTURAL THEORY II. (4 Credits)
Analysis of statically indeterminate structures (beams, frames, trusses). Deflections. Energy methods, introduction to matrix methods.
Prerequisites: CE 381 with C or better

CE 383. DESIGN OF STEEL STRUCTURES. (4 Credits)
Introduction to design of steel members, connections and structural systems. Lec/lab.
Prerequisites: CE 382 with C or better

CE 392. INTRODUCTION TO HIGHWAY ENGINEERING. (4 Credits)
Highway engineering standards, geometric design, cross section and roadside design, highway surfaces, pavement design, highways and the environment, highway construction and maintenance.
Prerequisites: (ENGR 212 with C or better or ENGR 212H with C or better) and CE 361 [C]

CE 401. RESEARCH. (1-16 Credits)
This course is repeatable for 16 credits.

CE 403. THESIS. (1-16 Credits)
This course is repeatable for 16 credits.

CE 405. READING AND CONFERENCE. (1-16 Credits)
This course is repeatable for 16 credits.

CE 406. PROJECTS. (1-16 Credits)
This course is repeatable for 16 credits.

CE 407. SEMINAR. (1-3 Credits)
Understanding complexity and systems thinking.
Equivalent to: CE 407H
This course is repeatable for 16 credits.

CE 407H. SEMINAR. (1-3 Credits)
Understanding complexity and systems thinking.
Attributes: HNRS – Honors Course Designator
Equivalent to: CE 407
This course is repeatable for 16 credits.

CE 408. WORKSHOP. (1-3 Credits)
This course is repeatable for 3 credits.

CE 410. INTERNSHIP. (1-12 Credits)
This course is repeatable for 16 credits.

CE 411. OCEAN ENGINEERING. (4 Credits)
Introduction to linear wave theory and wave forces on piles. Guided design of wave gauge facility at Coos Bay, Oregon, that requires synthesizing fluid mechanics, structural design and foundation design.
Prerequisites: CE 313 with C or better or CEM 311 with C or better

CE 412. HYDROLOGY. (4 Credits)
Fundamentals of hydrology, the hydrologic cycle, precipitation, streamflow, hydrograph analysis and hydrologic measurements.

CE 413. GIS IN WATER RESOURCES. (3 Credits)
Course presents Geographic Information System (GIS) technology for developing solutions to water resource problems: water quality, availability, flooding, the natural environment, and management of water resources. Typical GIS data models for hydrologic information are presented. Synthesis of geospatial and temporal water resources to support hydrologic analysis and modeling are covered.
CE 415. COASTAL INFRASTRUCTURE. (3 Credits)
Planning and design criteria of coastal infrastructure, including breakwaters, jetties, sea walls, groins, piers, submerged pipelines, harbor design, and tsunami defense. Use of laboratory models, numerical simulations, and field observations for design.
Prerequisites: CE 313 with C or better

CE 417. HYDRAULIC ENGINEERING DESIGN. (4 Credits)
Theory, planning, analysis, and design of hydraulic structures. Application of basic principles detailed analysis and design. Engineering planning and design of water resource systems.
Prerequisites: CE 313 with C or better

CE 418. CIVIL ENGINEERING PROFESSIONAL PRACTICE. (3 Credits)
Engineering career paths; ethics and professionalism, project planning, execution and delivery; team building/management; marketing proposals; engineering overseas; dispute resolution; partnering; effective decision making; uncertainty and risk analysis; and current industry design and construction methods. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisites: CE 382 with C or better and CE 313 [C] and (CE 372 [C] or FE 315 [C])

CE 419. CIVIL INFRASTRUCTURE DESIGN. (3 Credits)
A capstone design project experience exposing students to problems and issues similar to those encountered in the practice of civil engineering. Students should have completed ALL other required courses in their degree program prior to registering for this course. Lec/rec.
Attributes: CWIC – Core, Skills, WIC
Prerequisites: CE 418 with C or better

CE 420. ENGINEERING PLANNING. (4 Credits)
The application of systems analysis to structuring, analyzing, and planning for civil engineering projects. Concept of the system and its environment; setting goals, objectives, and standards; evaluation criteria; solution generation and analysis; evaluation and optimization. Project management using precedence node diagramming; resource allocation and leveling; time-cost trade-off; and PERT.

CE 424. CONTRACTS AND SPECIFICATIONS. (4 Credits)
Fundamentals of construction industry contracts, including technical specifications, and issues related to time, money, warranty, insurance, and changed conditions.

CE 427. TEMPORARY CONSTRUCTION STRUCTURES. (4 Credits)
Design and construction of temporary structures including formwork, shoring, and earth retaining structures.
Prerequisites: (CE 321 with C or better or CCE 321 with C or better) and (FE 315 [C] or CE 372 [C]) and (CEM 383 [C] or CE 383 [C])

CE 428. PROJECT MANAGEMENT FOR CIVIL ENGINEERS. (4 Credits)
Provides the prospective civil engineer with the technical knowledge and familiarity necessary to successfully and confidently manage projects of different sizes and complexity levels. It relies on basic knowledge and techniques developed by the Project Management Institute (PMI) and real-world examples (through lectures, example projects, case studies, and guest speakers) from the public and private sectors.

CE 461. PHOTOGRAMMETRY. (3 Credits)
Geometry of terrestrial and vertical photographs, flightline planning, stereoscopy and parallax, stereoscopic plotting instruments, analytical photogrammetry, orthophotography, introduction to photo interpretation, and aerial cameras.
Prerequisites: CE 361 with C or better or CEM 263 with C or better or FE 208 with C or better

CE 463. CONTROL SURVEYING. (4 Credits)
Global Positioning Systems (GPS) theory, networks, and fieldwork; control specifications, methods and problems in obtaining large area measurements; precise leveling; network adjustments using least square techniques; field instrument adjustments.
Prerequisites: CE 361 with C or better or CEM 263 with C or better or FE 208 with C or better

CE 465. OREGON LAND SURVEY LAW. (3 Credits)
Introduction to U.S. public land survey; Oregon state statutes, common law decisions, and administrative rules dealing with boundary law; case studies; unwritten land transfers; original and resurvey platting laws; guarantees of title; deed descriptions.
Prerequisites: CE 361 with C or better or CEM 263 with C or better or FE 208 with C or better

CE 469. PROPERTY SURVEYS. (3 Credits)
U.S. public land survey restoration of corners, subdivision of sections; topographic mapping; subdivision and partition plats, resurvey plats, subdivision design; introduction to LIS/GIS; field astronomy.
Prerequisites: CE 361 with C or better or CEM 263 with C or better or FE 208 with C or better

CE 471. FOUNDATIONS FOR STRUCTURES. (3 Credits)
Criteria, theory, design, and construction for foundations of structures; use of in-situ tests for geotechnical engineering; computer applications.
Prerequisites: CE 373 with C or better or FE 316 with C or better

CE 479. SLOPE AND EMBANKMENT DESIGN. (3 Credits)
A comprehensive overview of evaluating stability and performance for natural and engineered slopes. Design aspects include construction of road embankments, slope remediation techniques and application of geosynthetics for slope stabilization, slope and wall construction, and drainage. CROSSLISTED as FE 479/FE 579.
Prerequisites: CE 373 with C or better or FE 316 with C or better
Equivalent to: FE 479

CE 481. REINFORCED CONCRETE I. (4 Credits)
Basic principles of reinforced concrete design; strength, stability, and serviceability criteria; design of reinforced concrete members for flexure and shear. Detailing, development length and splices.
Prerequisites: CE 382 with C or better

CE 482. MASONRY DESIGN. (3 Credits)
A critical examination in depth of masonry design topics.
Prerequisites: CE 481 with C or better

CE 484. WOOD DESIGN. (4 Credits)
Study of basic wood properties and design considerations. Design and behavior of wood connectors, beams, columns and beam columns. Introduction to plywood and glued laminated members. Analysis and design of structural diaphragms and shear walls. Lec/lab.
Prerequisites: CE 383 with C or better or CE 481 with C or better

CE 486. PRESTRESSED CONCRETE. (3 Credits)
Prestressed concrete analysis and design, systems of prestressing, materials, economics.
Prerequisites: CE 481 with C or better

CE 491. TRANSPORTATION ENGINEERING. (3 Credits)
Introduction to transportation engineering systems characteristics, traffic estimation, comprehensive transportation planning, highway economics, driver and vehicle characteristics, highway operations and capacity, signalization and control. Introduction to intelligent transportation.
Prerequisites: CE 392 with C or better and ST 314 [C]
CE 492. PAVEMENT STRUCTURES. (3 Credits)
Design and rehabilitation of pavement structures for streets, highways, and airports.
Prerequisites: CE 392 with C or better

CE 499. SPECIAL TOPICS. (1-16 Credits)
This course is repeatable for 16 credits.

CE 501. RESEARCH. (1-16 Credits)
This course is repeatable for 16 credits.

CE 503. THESIS. (1-16 Credits)
This course is repeatable for 999 credits.

CE 505. READING AND CONFERENCE. (1-16 Credits)
This course is repeatable for 16 credits.

CE 506. PROJECTS. (1-16 Credits)
This course is repeatable for 16 credits.

CE 507. SEMINAR. (1-16 Credits)
This course is repeatable for 16 credits.

CE 508. WORKSHOP. (1-3 Credits)
Graded P/N.
This course is repeatable for 3 credits.

CE 510. INTERNSHIP. (1-16 Credits)
This course is repeatable for 16 credits.

CE 511. OCEAN ENGINEERING. (4 Credits)
Introduction to linear wave theory and wave forces on piles. Guided design of wave gauge facility at Coos Bay, Oregon, that requires synthesizing fluid mechanics, structural design and foundation design.

CE 512. HYDROLOGY. (4 Credits)
Fundamentals of hydrology, the hydrologic cycle, precipitation, streamflow, hydrograph analysis and hydrologic measurements.

CE 513. GIS IN WATER RESOURCES. (3 Credits)
Course presents Geographic Information System (GIS) technology for developing solutions to water resource problems: water quality, availability, flooding, the natural environment, and management of water resources. Typical GIS data models for hydrologic information are presented. Synthesis of geospatial and temporal water resources to support hydrologic analysis and modeling are covered.

CE 514. GROUNDWATER HYDRAULICS. (4 Credits)
Principles of groundwater flow and chemical transport in confined and unconfined aquifers, aquifer testing and well construction. Design of dewatering and contaminant recovery systems.
Prerequisites: CE 547 with C or better

CE 515. COASTAL INFRASTRUCTURE. (3 Credits)
Planning and design criteria of coastal infrastructure, including breakwaters, jetties, sea walls, groins, piers, submerged pipelines, harbor design, and tsunami defense. Use of laboratory models, numerical simulations, and field observations for design.

CE 517. HYDRAULIC ENGINEERING DESIGN. (4 Credits)
Theory, planning, analysis, and design of hydraulic structures. Application of basic principles detailed analysis and design. Engineering planning and design of water resource systems.

CE 518. GROUNDWATER MODELING. (4 Credits)
Application of numerical methods to the solution of water flow and solute transport through saturated and unsaturated porous media. Analysis of confined and unconfined aquifers. Computer solution of large-scale field problems including groundwater contamination and aquifer yield.
Prerequisites: CE 514 with C or better

CE 520. ENGINEERING PLANNING. (4 Credits)
The application of systems analysis to structuring, analyzing, and planning for civil engineering projects. Concept of the system and its environment; setting goals, objectives, and standards; evaluation criteria; solution generation and analysis; and evaluation and optimization. Project management using precedence node diagramming; resource allocation and leveling; time-cost trade-off, and PERT.

CE 524. CONTRACTS AND SPECIFICATIONS. (4 Credits)
Fundamentals of construction industry contracts, including technical specifications, and issues related to time, money, warranty, insurance, and changed conditions.

CE 526. ADVANCED CONCRETE MATERIALS. (3 Credits)
Cement hydration, supplementary cementing materials, micro to macro scale property development, mixture design and proportioning including material selection for sustainable design practices, durability aspects including freeze-thaw attack, corrosion of reinforcing steel, sulfate attack and alkali-silica reaction, recent advances in concrete technology.

CE 527. TEMPORARY CONSTRUCTION STRUCTURES. (4 Credits)
Design and construction of temporary structures including formwork, shoring, and earth retaining structures.

CE 528. PROJECT MANAGEMENT FOR CIVIL ENGINEERS. (4 Credits)
Provides the prospective civil engineer with the technical knowledge and familiarity necessary to successfully and confidently manage projects of different sizes and complexity levels. It relies on basic knowledge and techniques developed by the Project Management Institute (PMI) and real-world examples (through lectures, example projects, case studies, and guest speakers) from the public and private sectors.

CE 530. SELECTED TOPICS IN STRUCTURAL ANALYSIS AND MECHANICS. (3 Credits)
A critical, in-depth examination of topics selected by the instructor from among topics not covered in other structural analysis and mechanics courses.
Prerequisites: CE 585 with C or better
This course is repeatable for 16 credits.

CE 531. STRUCTURAL MECHANICS. (3 Credits)
Theories of failure, multi-axial stress conditions, torsion, shear distortions, energy methods of analysis, beams on elastic foundations. Nonlinear and inelastic behavior.

CE 532. FINITE ELEMENT ANALYSIS. (4 Credits)
Applications of the finite element method to structural analysis, fluid flow and elasticity problems. Use and development of large finite element computer programs.
Prerequisites: (CE 585 with C or better or ME 520 with C or better)

CE 533. STRUCTURAL STABILITY. (3 Credits)
Stability theory and applications, with emphasis on design of steel structures.

CE 534. STRUCTURAL DYNAMICS. (4 Credits)
Analytical and numerical solutions for single, multi-degree of freedom and continuous vibrating systems. Behavior of structures, dynamic forces and support motions. Seismic response spectra analysis.

CE 535. INTRODUCTION TO RANDOM VIBRATIONS. (4 Credits)
Introduction to probability theory and stochastic processes. Correlation and spectral density functions. Response of linear systems to random excitations. First excursion and fatigue failures. Applications in structural and mechanical system analysis and design.
Prerequisites: CE 534 with C or better or (ME 422 with C or better or ME 522 with C or better)
CE 536. MATRIX METHODS OF STRUCTURAL ANALYSIS. (4 Credits)
Development of matrix methods for linear structural analysis. Force
and displacement methods of analysis. Virtual work principles. Use of
computer programs to analyze structures. Introduction to the finite-
element method.

CE 537. NONLINEAR STRUCTURAL ANALYSIS. (4 Credits)
Material and geometric nonlinear analysis of frame and truss structures.
Solution strategies for nonlinear structural analysis. Nonlinear
constitutive models of steel and reinforced concrete members.
Development and use of computer programs for nonlinear analysis.
Prerequisites: CE 585 with C or better

CE 538. STRUCTURAL RELIABILITY AND RISK ANALYSIS. (4 Credits)
Application of probability and statistics in the reliability-based analysis
and design of civil and mechanical engineering systems. Probabilistic
modeling of loading and resistance including load and resistance factor
design. Introduction to risk analysis and robustness.
Prerequisites: (CE 536 with C or better or ME 520 with C or better)

CE 540. SPECIAL TOPICS IN HYDRAULIC ENGINEERING. (3-4 Credits)
Introduction to the tools and methods employed to characterize
hydrologic properties of subsurface systems. Hands-on use of GPR, TDR,
resistivity, and methods of determining hydraulic conductivity, sorptivity,
bulk density, and other fundamental hydrologic properties.
This course is repeatable for 16 credits.

CE 543. APPLIED HYDROLOGY. (4 Credits)
Advanced treatment of hydrology covering major components of the
hydrological cycle with special emphasis on surface water; hydrologic
analysis and design of water resource systems; runoff prediction; and
simulation of surface water systems. Offered alternate years.
Equivalent to: BRE 543

CE 544. OPEN CHANNEL FLOW. (3 Credits)
Steady, uniform, and nonuniform flow in natural and artificial open
channels; unsteady flow; interaction of flow with river structures; and
computational methods.
Equivalent to: BEE 544

CE 547. WATER RESOURCES ENGINEERING I: PRINCIPLES OF FLUID
MECHANICS. (4 Credits)
Fluid mechanics for water resources engineers, classifications of
fluid flows; fluid statics and dynamics, incompressible viscous flows;
dimensional analysis; applications to fluid machinery, flow through
porous media, fluid motion in rivers, lakes, oceans.

CE 548. WATER QUALITY DYNAMICS. (3 Credits)
Mass balance, advection and diffusion in streams, lakes and estuaries;
thermal pollution, heat balance, oxygen balance, and eutrophication;
mathematical models; and numerical solutions.

CE 551. COMPUTER-AIDED SITE AND ROAD DESIGN. (4 Credits)
Site development and road design principles and application to a
comprehensive design project using computer-based digital terrain model
software tools. Lec/lab/rec.

CE 552. ISOLATED SIGNALIZED INTERSECTIONS. (3 Credits)
Relationships between signal display, user response, vehicle detection,
and signal timing parameters are examined in detail. Traffic simulation
is introduced to visualize and design the various elements of isolated
signalized intersections.

CE 553. RAILROAD ENGINEERING. (3 Credits)
The principal subject of this course is the railway infra-structure and
operational issues related to high speed passenger rail and freight rail
(class 1 and regional rail). The course will cover the techniques used to
design, construct, monitor and maintain railway track. Class will include
field trips.
Corequisites: CE 392

CE 554. DRIVING SIMULATION. (3 Credits)
Relationships between the functional elements of driving simulation
(simulation computer processing, sensory feedback generation, sensory
display devices, and the human operator) are examined in detail. The
role of driving simulation in transportation engineering research and
practice is also considered in depth. Students will design experiments,
analyze and interpret data, and extrapolate simulator results to real-world
scenarios.

CE 556. TRANSPORTATION SAFETY ANALYSIS. (3 Credits)
Provides students with a general knowledge of major transportation
safety issues and a general background in the application of various
statistical and econometric safety analysis techniques. In addition,
this course presents a number of model-estimation methods used in
transportation safety data analysis, and other subject areas that deal
with safety analysis.

CE 557. NETWORK FLOW ANALYSIS AND OPTIMIZATION. (3 Credits)
Acquaints students with the basic elements of operations research
through transportation networks, optimal paths in transportation
networks, vehicle routing and scheduling problems on networks,
facility location problems, transportation network design problems,
transportation network flows, and to indicate the directions for future
research in this area. Although the course utilizes examples from
transportation, the techniques and models are generalizable to other
areas of engineering, e.g., water networks, computer networks, energy
networks, agricultural, power, telecommunication, etc.

CE 560. SELECTED TOPICS IN GEOMATIC ENGINEERING. (0-4 Credits)
Selected topics on contemporary problems in geomatics engineering;
application of ongoing research from resident and visiting faculty.
This course is repeatable for 16 credits.

CE 561. PHOTOGRAMMETRY. (3 Credits)
Geometry of terrestrial and vertical photographs, flightline planning,
stereoscopy and parallax, stereoscopic plotting instruments, analytical
photogrammetry, orthophotography, introduction to photo interpretation,
and aerial cameras.

CE 562. DIGITAL TERRAIN MODELING. (4 Credits)
Fundamentals of LIDAR and creating digital terrain models.
Computational geometry, Delaunay triangulations, spline interpolations,
statistical gridding methods, ground filtering, data optimizations, and
advanced topics in 3D modeling.

CE 563. CONTROL SURVEYING. (4 Credits)
Global Positioning Systems (GPS) theory, networks, and fieldwork;
control specifications, methods and problems in obtaining large area
measurements; precise leveling; network adjustments using least square
techniques; field instrument adjustments.

CE 565. OREGON LAND SURVEY LAW. (3 Credits)
Introduction to U.S. public land survey; Oregon state statutes, common
law decisions, and administrative rules dealing with boundary law; case
studies; unwritten land transfers; original and resurvey platting laws;
guarantees of title; deed descriptions.
CE 566. 3D LASER SCANNING AND IMAGING. (4 Credits)
Fundamentals of lidar acquisition, registration, processing, modeling, analysis, and verification. Use of sensor platforms for 3D acquisition. Effective data management procedures. Introduction to other imaging techniques including structure from motion and structured light. Lec/lab.

CE 567. COASTAL REMOTE SENSING. (4 Credits)
Application of remote sensing technologies (e.g., unmanned aircraft systems, multi- and hyperspectral imagery, high-resolution commercial satellite imagery, synthetic-aperture radar, and topographic and bathymetric lidar) to coastal mapping and charting, coastal engineering and coastal zone management. Both the theory and applications of advanced remote sensing technologies are covered. Lec/lab.

CE 568. LEAST SQUARES ADJUSTMENTS. (3 Credits)
Examines the theory of random error and statistical testing. Discusses the propagation of error in both indirect observations and direct observations from survey. Studies weights of observations and the principles of least squares. Explains how to adjust redundant observations in level nets, horizontal surveys, GNSS networks, and GNSS and terrestrial survey networks by least squares. Estimates the error ellipses of the adjusted observations. Evaluates methods for performing coordinate transformations.

CE 569. PROPERTY SURVEYS. (3 Credits)
U.S. public land survey; restoration of corners, subdivision of sections; topographic mapping; subdivision and partition plats, resurvey plats, subdivision design; introduction to LIS/GIS; field astronomy.

CE 570. GEOTECHNICAL SPECIAL TOPICS. (1-16 Credits)
Development and management of actual projects through the examination of case histories; evaluation of geotechnical data; development of design recommendations and preparation of project reports. This course is repeatable for 16 credits.

CE 571. ADVANCED FOUNDATION ENGINEERING. (4 Credits)
Presents the planning, analysis, and design of shallow and deep foundations from the geotechnical engineering perspective. Topics supporting course objectives include planning and execution of subsurface investigations, interpretation of in-situ tests, analysis and design of deep and shallow foundations, including geotechnical capacity, and immediate settlement. Assessment of deep foundation installation, axial and lateral loading tests, and group effects is presented. Evaluation of foundation performance is conducted under deterministic and probabilistic frameworks.

CE 572. ADVANCED GEOTECHNICAL LABORATORY. (4 Credits)
Examination of soil composition and engineering properties of soils including volume change, pore pressure generation, strength, and deformation behavior of soils in the laboratory. Advanced static and cyclic shear strength testing of soils will also be discussed. Lec/lab.

CE 574. ENGINEERING PROPERTIES OF SOILS. (5 Credits)
Advanced laboratory experimental methods for measurement of soil properties. Analysis of experimental data, and methods to display data for 2D and 3D experiments. Compositional and environmental factors affecting the stress-strain, volume change, compressibility, shear strength behavior of sand, clay, and compacted soils in 2D and 3D. Stress and strain invariants and modeling of failure criteria.

CE 575. EARTH RETENTION AND SUPPORT. (4 Credits)
Presents the theory and practice of design and construction of earth retaining structures. Topics include rigid and flexible retaining structures, ranging from gravity and cantilever systems, cantilever and anchored sheet piling, tied-back shoring elements, soil nailing, and mechanically stabilized earth walls. These topics are developed with a view on compaction stresses and surface loading, and invokes approaches that range from the static equations of equilibrium to empirical rules of thumb.

CE 576. GROUND IMPROVEMENT. (3 Credits)
Presents the analysis and design of ground improvement techniques. Topics supporting course objectives include design for accelerated settlement (surcharge design) with and without pre-fabricated vertical drains, vibro-compaction, vibro-replacement (stone columns) and aggregate piers, deep soil mixing, jet grouting, EPS geofoam, and other improvement techniques for improving soil strength and stability, and limiting deformations and the effects of liquefaction. Prerequisites: CE 572 with C or better and CE 577 [C]

CE 577. STATIC AND DYNAMIC SOIL BEHAVIOR. (3 Credits)
An advanced coverage of volume change and strength behavior of soil. Specific course topics include effective stress, one-dimensional compression of soil, rate of soil consolidation, Mohr circle analysis, shear strength of sands, clays, and silts, and dynamic soil properties, strength, and testing.

CE 578. GEOTECHNICAL EARTHQUAKE ENGINEERING. (4 Credits)
Major course topics include engineering seismology, strong ground motion, seismic hazard analysis, soil dynamics, seismic site response, earthquake motion selection, liquefaction, and seismic slope stability. Attention will be given to earthquakes created by the Cascadia Subduction Zone. Lec/lab.

CE 579. SLOPE AND EMBANKMENT DESIGN. (3 Credits)
A comprehensive overview of evaluating stability and performance for natural and engineered slopes. Design aspects include construction of road embankments, slope remediation techniques and application of geosynthetics for slope stabilization, slope and wall construction, and drainage. CROSSTLISTED as FE 479/FE 579.
Equivalent to: FE 579

CE 580. SELECTED TOPICS IN STRUCTURAL DESIGN. (3 Credits)
A critical examination in depth of topics selected by the instructor from among topics not covered in other structural design courses. This course is repeatable for 18 credits.

CE 581. REINFORCED CONCRETE I. (4 Credits)
Basic principles of reinforced concrete design; strength, stability, and serviceability criteria; design of reinforced concrete members for flexure and shear. Detailing, development length and splices.

CE 582. MASONRY DESIGN. (3 Credits)
A critical examination in depth of masonry design topics.

CE 583. BRIDGE DESIGN. (3 Credits)
AASHTO specifications for bridge design; load models; design for moving loads; design and analysis of bridge decks and simple and continuous bridge spans.

CE 584. WOOD DESIGN. (4 Credits)
Study of basic wood properties and design considerations. Design and behavior of wood connectors, beams, columns and beam columns. Introduction to plywood and glued laminated members. Analysis and design of structural diaphragms and shear walls. Lec/lab. CROSSTLISTED as WSE 558.
Equivalent to: WSE 558
CE 586. PRESTRESSED CONCRETE. (3 Credits)
Prestressed concrete analysis and design, systems of prestressing, materials, economics.

CE 588. PROBABILITY-BASED ANALYSIS AND DESIGN. (4 Credits)
Application of probability and statistics in the analysis and design of civil and mechanical engineering systems. Probabilistic modeling of loading and resistance. Probability-based design criteria including load and resistance factor design.

CE 589. SEISMIC DESIGN. (4 Credits)
Design of structures to resist the effects of earthquakes. Introduction to structural dynamics, dynamic analysis, seismic design philosophy, code requirements, and detailing for steel and reinforced concrete.

CE 590. SELECTED TOPICS IN TRANSPORTATION ENGINEERING. (1-3 Credits)
Selected topics on contemporary problems in transportation engineering; application of ongoing research from resident and visiting faculty. This course is repeatable for 9 credits.

CE 591. TRANSPORTATION SYSTEMS ANALYSIS, PLANNING, AND POLICY. (3 Credits)

CE 592. PAVEMENT STRUCTURES. (3 Credits)
Design and rehabilitation of pavement structures for streets, highways, and airports.

CE 593. TRAFFIC FLOW ANALYSIS AND CONTROL. (4 Credits)
Traffic operations and control systems; traffic flow theory and stream characteristics; capacity analysis; traffic models and simulation; accident and safety improvement. Offered alternate years.

CE 594. TRANSPORT FACILITY DESIGN. (4 Credits)
Location and design of highways, and other surface transportation terminals; design for safety, energy efficiency, and environmental quality. Offered alternate years. Lec/rec.

CE 595. TRAFFIC OPERATIONS AND DESIGN. (3 Credits)
Traffic operations and engineering; human and vehicular characteristics; traffic stream characteristics; highway capacity analysis; intersection operation, control and design.

CE 596. PAVEMENT EVALUATION AND MANAGEMENT. (3 Credits)
Advanced topics in pavement evaluation techniques and pavement management procedures.

CE 597. PUBLIC TRANSPORTATION. (3 Credits)
Characteristics and nature of public transportation systems, including bus, light and heavy rail; financing policy considerations; planning transit service; managing and operating transit systems for small and large urban areas. Offered alternate years.

CE 598. AIRPORT PLANNING AND DESIGN. (3 Credits)
Characteristics and nature of the air transport system. Airport financing, air traffic control. Analysis and design of airports and the airport planning processes. Airport appurtenances. Airport pavement design, environmental facilities and drainage. Offered alternate years.

CE 599. INTELLIGENT TRANSPORTATION SYSTEMS. (3 Credits)
Introduction to intelligent transportation systems, including enabling surveillance, navigation, communication and computer technologies. Application of technologies for monitoring, analysis evaluation and prediction of transportation system performance. Intervention strategies, costs and benefits, safety, human factors, institutional issues and case studies. Offered alternate years.

CE 601. RESEARCH. (1-16 Credits)
This course is repeatable for 16 credits.

CE 603. THESIS. (1-16 Credits)
This course is repeatable for 999 credits.

CE 605. READING AND CONFERENCE. (1-16 Credits)
This course is repeatable for 16 credits.

CE 606. PROJECTS. (1-16 Credits)
This course is repeatable for 16 credits.

CE 607. OCEAN ENGINEERING SEMINAR. (1 Credit)
Presentations from on-campus and off-campus speakers discussing state of technology topics in ocean engineering research, development, and construction. Graded P/N. This course is repeatable for 16 credits.

CE 630. OCEAN WAVE MECHANICS I. (3 Credits)
Linear wave boundary value problem formulation and solution, water particle kinematics, shoaling, refraction, diffraction, and reflection. Linear long wave theory with applications to tides, seiching, and storm surge. CROSSLISTED as OC 630. Lec/lab.
Equivalent to: OC 630

CE 631. OCEAN WAVE MECHANICS II. (3 Credits)
Second in the sequence of ocean wave engineering mechanics, covers the following topics: introduction to long wave theory, wave superposition, wave height distribution, and the wind-wave spectrum, introduction to wave forces, and basic nonlinear properties of water waves. May include additional selected topic in wave mechanics. CROSSLISTED as OC 631.
Prerequisites: (CE 630 with C or better or OC 630 with C or better)
Equivalent to: OC 631

CE 634. LONG WAVE MECHANICS. (3 Credits)
Theory of long waves. Depth-integrated Euler's equation and its jump conditions. Evolution equations and their solutions. Nonlinear shallow-water waves, the Korteweg-deVries equation and Boussinesq equation. Boundary-layer effects. Shallow-water waves on beaches. Applications of the fundamentals to problems of tsunamis. CROSSLISTED as OC 634.
Prerequisites: (CE 630 with C or better and CE 631 [C])
Equivalent to: OC 634

CE 635. APPLIED MODELING OF NEARSHORE PROCESSES. (4 Credits)
An introduction to numerical modeling of the nearshore ocean, providing hands-on experience with state-of-the-art numerical models for wave propagation, nearshore circulation, planform shoreline evolution and bathymetric profile evolution. The focus is on review of model requirements, detailed study of several specific models for several domains of interest, application to coastal phenomena, and the interpretation of model results. Offered alternate years. CROSSLISTED as OC 635.
Equivalent to: OC 635
CE 639. DYNAMICS OF OCEAN STRUCTURES. (3 Credits)
Dynamic response of fixed and compliant structures to wind, wave and current loading; Morison equation and diffraction theory for wave and current load modeling, time and frequency domain solution methods; application of spectral and time series analyses; system parameter identification; and stochastic analysis of fatigue and response to extreme loads. Offered alternate years.

CE 640. SELECTED TOPICS IN OCEAN AND COASTAL ENGINEERING. (1-3 Credits)
Selected topics on contemporary problems in ocean and coastal engineering; application of ongoing research from resident and visiting faculty. Offered alternate years. This course is repeatable for 9 credits.

CE 642. RANDOM WAVE MECHANICS. (3 Credits)
Random wave theories, probability and statistics of random waves and wave forces, time series analyses of stochastic processes, ocean wave spectra. Offered alternate years. Prerequisites: CE 630 with C or better

CE 643. COASTAL ENGINEERING. (3 Credits)
Coastal sediment transport including nearshore currents, longshore onshore-offshore transport, and shoreline configuration; equilibrium beach profile concept with application to shore protection; shoreline modeling; tidal inlet hydrodynamics and inlet stabilization; design criteria for soft structures. Offered alternate years. Prerequisites: CE 630 with C or better

CE 645. WAVE FORCES ON STRUCTURES. (3 Credits)
Wave forces on small and large members, dimensional analyses and scaling of equations, identification and selection of force coefficients for Morison equation; compatibility of wave kinematics and force coefficients in Morison equation, diffraction and radiation of surface gravity waves by large floating bodies, wavemaker problem, and reciprocity relations. Prerequisites: CE 630 with C or better

CE 647. OCEAN AND COASTAL ENGINEERING MEASUREMENTS. (3 Credits)
Hands-on experience in the conduct of field and laboratory observations, including waves, currents, wind, tides, tsunami, sediments, bathymetry, shore profiles, wave forces on structures, and structural response. Online data archival and retrieval systems. Prerequisites: CE 630 with C or better

CE 661. KINEMATIC POSITIONING AND NAVIGATION. (3 Credits)
Application of Global Navigation Satellite System (GNSS) aided Inertial Navigation Systems (INS) to directly georeference survey data acquired from a moving platform, such as an unmanned aircraft system (UAS), conventional aircraft, survey boat, or all-terrain vehicle. Topics include 3D coordinate transformations, dead-reckoning, inertial navigation, kinematic GNSS, Kalman filtering, and sensor modeling.

CE 808. WORKSHOP. (1-16 Credits)
This course is repeatable for 16 credits.