

CIVIL ENGINEERING (CIVL)

CIVL 200 Mechanics of Materials (3 semester hours)

Development of relationships between loads applied to an elastic body to stresses and deformations produced in the body, the relation between stresses and strains, approaches for finding necessary dimensions of a member with respect to material capabilities and design constraints. Prerequisite: ENGR 200.

CIVL 210 Surveying & Mapping (3 semester hours)

Study of basic surveying instruments and related computations for topographic surveys, horizontal and vertical curves, and the design of highways. The course will include computer aided design and geographic information systems (applications of AutoCAD to civil engineering design and fundamentals of GIS using ArcView). Sophomore standing required. University Core fulfilled: Flag: Information Literacy.

CIVL 230 Particle Dynamics (2 semester hours)

The objective of the course is to review particle dynamics and to introduce fundamentals of structural dynamics through theory and lab. Topics in particle dynamics include Newton's laws, particle kinematics, force and acceleration. Topics in structural dynamics include single and multiple degree-of-freedom structures, earthquake characteristics, and response of linear systems. Structural dynamics experiments will be conducted. Prerequisite: ENGR 200.

CIVL 250 Thermal-Fluid Systems (3 semester hours)

The fundamental concepts of thermodynamics including properties, work, and heat; first and second laws; entropy; irreversible processes; thermodynamic analysis of power cycles and refrigeration; fluid statics; Bernoulli's equation; heat convection and radiation. Prerequisite: ENGR 200.

CIVL 305 Structural Theory (3 semester hours)

Introduction to the International Building Code. Analysis of determinate and indeterminate deformable structures using classical methods and an introduction to computer methods of analysis. Prerequisites: CIVL 200 and MATH 234 and MATH 245.

CIVL 310 Fluid Mechanics I (3 semester hours)

Properties of fluids, fluid statics, kinematics, energy, hydrodynamics, momentum and dynamic forces, steady flow of compressible and incompressible fluids. Prerequisites: CIVL 250 and MATH 234 and MATH 245 or concurrent enrollment.

CIVL 311 Fluid Mechanics Lab (1 semester hour)

A companion laboratory of CIVL 310. Corequisite: CIVL 310.

CIVL 320 Introduction to Environmental Engineering (3 semester hours)

Introduction to elements of water treatment, water pollution control, solid and hazardous waste disposal, and air pollution control. The interrelationships of the movement of pollutants between the land, air, and water media are discussed. Lecture, 3 hours. Core: Explorations: Nature of Science, Technology, and Mathematics (Civil Engineering majors only). Prerequisites: BIOL 114, CHEM 114, MATH 132, and MATH 245 or concurrent enrollment.

CIVL 360 Structural Dynamics and Seismic Systems (4 semester hours)

Brief review of particle dynamics. Introduction to fundamentals of structural dynamics through theory and lab. Free and forced vibration of discrete and multiple degree of freedom systems, continuous systems, design for earthquake loading, application of the Uniform Building Code to the seismic design of structures. Structural dynamics experiments will be conducted. Prerequisites: CIVL 2300 and MATH 234 and MATH 246.

CIVL 395 Engineering Economics and Decision Theory (3 semester hours)

The economic evaluation of engineering alternatives. Topics include: time value of money relationships, nominal and effective interest rates, present worth method, annual worth method, rate of return and incremental analysis, depreciation and income taxes, replacement analysis and benefit/cost analysis. Lecture, 3 hours. University Core fulfilled: Explorations: Understanding Human Behavior (Civil Engineering majors only). Prerequisite: MATH 132. Junior standing in Civil Engineering.

CIVL 398 Special Studies (0-4 semester hours)

CIVL 400 Fundamentals of Water and Wastewater Treatment (3 semester hours)

Fundamentals of water and wastewater treatment systems; water and wastewater characteristics, analysis and design and conventional water treatment systems and physical, chemical, and biological processes for wastewater treatment. Prerequisites: CIVL 310 and CIVL 320. University Core fulfilled: Flag: Oral Skills.

CIVL 410 Soil Mechanics (4 semester hours)

Physical and mechanical properties of soil, consolidation, settlement of structures, shear strength, analysis of earth pressures, bearing capacity, slope stability, flow through porous media, and open-ended design problems. Prerequisites: CIVL 200 and CIVL 310. University Core fulfilled: Flag: Writing.

CIVL 411 Design of Foundations and Earth Structures (3 semester hours)

Design methods for foundations and earth structures. Design of footings and piles including stability and settlement, slopes, and retaining structures. Prerequisite: CIVL 410.

CIVL 470 Civil & Environ Engr Seminar (1 semester hour)

CIVL 490 Civil & Environ Engineering Seminar (1 semester hour)

Presentations emphasizing the applications of civil and environmental engineering topics in professional practice and research; civil engineering employment opportunities; student group meetings and gatherings; and interaction with members of the LMU Civil Engineering and Environmental Science Council for Industry Partnerships. Credit/No Credit only.

CIVL 498 Special Studies (0-4 semester hours)

CIVL 499 Independent Studies (1-4 semester hours)

CIVL 504 Applied Fluid Mechanics (3 semester hours)

Fundamentals of fluid mechanics, and review of the underlying mathematical principles, viscosity, fluid statics, conservation of mass, energy equation, momentum principle, fluid flow in pipes, hydraulic machinery. Open to science majors interested in a master's degree in environmental science. Permission of instructor required.

CIVL 505 Aquatic Chemistry (3 semester hours)

Review of stoichiometry, oxidation-reduction reactions, thermodynamics, and chemical kinetics. Equilibrium chemistry concepts including acid-base, gas, and solid-liquid equilibria applied to aquatic systems with an emphasis on problem-solving methods to determine chemical speciation and pH effects in natural and treated aquatic systems. Prerequisite: CHEM 110 or CHEM 114.

CIVL 508 Contaminant Fate, Transport & Remediation (3 semester hours)

Introduction to physical, chemical, and biological processes governing the movement and fate of contaminants in the surface and coastal water environment. Practical quantitative problems solved based on contaminant mass transport, equilibrium partitioning, and chemical transformations in the environment. Regulatory implications and remediation approaches. Prerequisite: CIVL 320 or ENVS 358.

CIVL 510 Open Channel Hydraulics (3 semester hours)

Study of steady uniform and non-uniform flow in open channels; design of channels, transitions, confluences, culverts, and other hydraulic structures. Prerequisite: CIVL 310.

CIVL 511 Hydraulic Analysis and Design (3 semester hours)

Design and analysis of hydraulic structures and pump stations; rainfall-runoff models; determination of reservoir storage; unsteady flow and water hammer; flood routing techniques; sediment transport. Prerequisite: CIVL 310 or 504.

CIVL 512 Air Pollution Analysis (3 semester hours)

Detailed analysis of emission sources, emission calculation methods, and air pollution controls. The dispersion of air pollutants in the atmosphere (fates and lifetimes, dispersion modeling methods). In-depth techniques of conducting risk assessments due to exposure to air pollutants.

CIVL 515 Industrial Waste Management (3 semester hours)

Principles and methods of treatment and disposal of industrial wastes that may adversely affect the environment, including general characterization of wastes from industries of major significance and typical treatment processes involved. Regulatory constraints. Prerequisites: CIVL 400 and ENVS 533.

CIVL 517 Water Treatment Processes (3 semester hours)

Theory and practice of the physical and chemical treatment processes to treat water and wastewater including reactor performance, screening sedimentation, membrane and media filtration, adsorption, ion exchange, disinfection. Theory and practice of biological treatment of wastewater including activated sludge, attached growth systems, oxygen transfer, secondary clarification, nutrient removal, residuals stabilization and dewatering, natural treatment systems. Prerequisites: CIVL 3200 and CIVL 3410.

CIVL 518 Water Reuse and Desalination (3 semester hours)

Wastewater reuse and desalination are key components of future water supply systems. This course covers processes used for water reuse and membrane treatment systems. The objectives include understanding: 1) the rapidly expanding wastewater reuse market; 2) advanced treatment processes required for reuse; and 3) the roles and characteristics of membrane systems for treatment of water and wastewater along with desalination for seawater and brackish water. Existing reuse and membrane treatment systems are studied to understand how individual processes are integrated to meet the water quality objectives and treatment requirements for different applications. Prerequisite: CIVL 3200.

CIVL 519 Advanced Integrated Water Treatment Systems (3 semester hours)

Integrated design of water and wastewater treatment facilities from site and process selection, site layout, hydraulics, flow and material balances, pumping, odor control, and chemical feed systems. Includes the design of additional processes such as ozonation, air stripper, ion exchange, adsorption, nutrient removal, etc. Prerequisite: CIVL 500.

CIVL 520 Computers and Environmental Analysis (3 semester hours)

Applications of digital simulations in the analysis of problems in the environment, water quality modeling, numerical methods, statistical analysis, and use of a large scale application program. Prerequisite: MATH 131 or MATH 112 or MATH 122.

CIVL 526 Surface Water Hydrology (3 semester hours)

Study of the elements of the hydrologic cycle, rainfall, streamflow, infiltration, evapotranspiration, snowmelt, hydrographs, probability, river and reservoir routing, runoff determination using the rational method and hydrograph methods. Prerequisite: MATH 112 or MATH 122 or MATH 131.

CIVL 527 Urban Water Systems and Stormwater Management (3 semester hours)

Overview of the theory and practical applied hydraulic design in an urban setting. Topics include potable water conveyance facilities with pump stations and reservoirs; storm water conveyance systems including pipe, street gutter, storm drains, and culverts. Emphasis is placed on the design Low Impact Development (LID) bioretention, and other facilities for regulatory compliance and sustainability, as well as on the application of modeling software used in practice. Prerequisite: CIVL 3100.

CIVL 528 Groundwater Hydrology and Sustainable Management (3 semester hours)

Groundwater in California and other regions of the world is a critical component of our water supply portfolio, and proper management requires a judicious balance between municipal, agricultural, and environmental interests. In this course, students will learn about 1) the theory of groundwater occurrence and movement; 2) the engineering involved in groundwater extraction, replenishment, and protection; and 3) sustainable basin management strategies and optimization techniques. Specific course topics include theory of the movement and occurrence of water in a porous medium, Darcy's law, steady and unsteady flow in confined and unconfined aquifers, hydraulics of groundwater wells, municipal water well design, use of professional groundwater modeling software, optimization techniques to sustainably manage groundwater basin pumping, safe yield operation, artificial recharge, conjunctive use of groundwater and surface water supplies, seawater intrusion prevention, and sustainable basin management strategies and agreements. Prerequisite: MATH 112 or MATH 122 or MATH 131.

CIVL 529 Groundwater Contaminant Transport and Remediation (3 semester hours)

Processes affecting the transport and fate of inorganic and organic contaminants in groundwater. Emphasis is placed on processes involving phase equilibrium, mass transfer, dissolution, etc. Review of flow and contaminant transport models, remediation technologies, and practical/regulatory considerations. Prerequisite: CIVL 528.

CIVL 530 Design of Concrete Structures (3 semester hours)

Theory and design of reinforced concrete columns, beams, retaining walls, footings, and slabs. Application to design projects. Prerequisites: CIVL 200 and CIVL 305.

CIVL 532 Structural Steel Design (3 semester hours)

Fundamentals of load and resistance factor design of steel components, connections, and systems. Component designs include beams, composite beams, beam columns, tension and compression members, and simple connections. Introduction to computational modeling. Prerequisite: CIVL 200.

CIVL 533 Design of Wood Structures (3 semester hours)

The course addresses properties and behavior of wood products, design criteria using structural timber, glue laminated lumber, and panels, LRFD design of bending and compression members, frames, diaphragms, shear panels, and connection details, and use of resources such as building codes and the National Design Specifications. Prerequisite: CIVL 200.

CIVL 536 Nonlinear Structural Analysis (3 semester hours)

This course will cover nonlinear response and behavior of new and retrofitted buildings to earthquake ground motions. The course will be taught with lectures and projects (Perform 3D), using both prescriptive and performance-based design methodologies. Topics include nonlinear static and dynamic analysis, response spectra, component and system behavior, damping, latest research references for computational modeling. Corequisite: CIVL 305

CIVL 537 Building Information Modeling (3 semester hours)

This course focuses on the knowledge and skills required to create and utilize a Building Information Model (BIM) for construction building projects. This is a project-based course where students apply BIM concepts to real-life projects from the planning and design stages to the construction phase. The course also introduces the use of BIM for clash detection as well as for cost estimating and scheduling purposes. Junior standing or above required.

CIVL 538 Construction Management and Sustainability (3 semester hours)

Course provides students with an introduction to construction management and sustainable building practices and rating systems including CALGreen and Leadership in Energy and Environmental Design (LEED). Juniors and seniors only.

CIVL 539 Design of Masonry Structures (3 semester hours)

Analysis and design of masonry structures including the analysis and design of reinforced masonry beams, walls, columns and lateral design considerations. Corequisites: CIVL 305

CIVL 542 Design of Foundations and Earth Structures (3 semester hours)

Design methods for foundations and earth structures. Design of footings and piles including stability and settlement, slopes, and retaining structures. Prerequisite: CIVL 410.

CIVL 546 Geotechnical Earthquake Engineering (3 semester hours)

Introduction to engineering seismology and earthquake ground motions. Evaluation of dynamic soil properties, seismic site response analysis, soil liquefaction evaluation and mitigation, seismic slope stability, and seismic evaluation of dams and embankments. Prerequisite: CIVL 410 or ENVS 552.

CIVL 547 Dams and Levees (3 semester hours)

Evaluation of geotechnical, hydrology, and hydraulic components for the design and evaluation of dam and levee structures. Consideration of unconfined groundwater flow, filter design, embankment stability, open channels, and other related topics. Prerequisites: CIVL 406 and CIVL 410, or permission of the instructor.

CIVL 550 Fundamentals of Environmental Risk Management (2 semester hours)

The fundamental technical aspects and non-technical policy aspects of environmental health risk assessments. Basics of environmental chemistry partitioning fate and transport of pollutants in the atmosphere and water; human exposure scenarios, fundamentals of toxicology and epidemiology.

CIVL 551 Remote Sensing with Civil Engineering and Environmental Science Applications (3 semester hours)

The course introduces the fundamental concepts of remote sensing from space, remote sensing data, and image data processing. Topics include characteristics of electromagnetic spectrum and remote sensing devices, digital processing methods for interpreting, manipulating and analyzing remotely-sensed image data, and applications of satellite remote sensing to civil engineering and environmental fields. Prerequisite: MATH 112 or MATH 122 or MATH 131.

CIVL 553 Modeling Environmental and Water Resources Systems (3 semester hours)

This course provides an introduction to mathematical modeling techniques used to solve and interpret a variety of environmental and water resources engineering problems. Topics include numerical solution of ordinary and partial differential equations, optimization, and statistical analysis of model results. Prerequisite: CIVL 310.

CIVL 555 Computational Fluid Dynamics (3 semester hours)

In-depth study of applied computational methods for solving problems involving fluid and heat transport. Course will include both commercially available codes as well as self-generated solving routines. Topics include: numerical solutions to PDEs, steady flow solutions, unsteady flow solutions, flows involving heat transfer. Prerequisite: CIVL 310 or CIVL 506 or CIVL 606. Senior or graduate standing required. Majors only.

CIVL 557 Finite Element Methods (3 semester hours)

Introduction to the theory and application of finite element methods. Review of the fundamentals of analytical models, elasticity, and structural mechanics. Review of matrix theory and calculation of variations. General process for the development of a finite element solution. Derivations of basic elements, including those for trusses, plane stress and plane strain, beams, plates, and solids. Discussion of the issues of conformity and completeness. Higher order interpolation functions and isoparametric elements. Solutions and applications to problems in structural mechanics, heat transfer, structural dynamics, and elastic stability. Practical examples. Prerequisites: CIVL 3350 and CIVL 3150.

CIVL 571 Air Quality, Control, and Management (3 semester hours)

Air pollution effects, and principal regulations, including greenhouse gases and environmental justice, emission standards, criteria and toxic pollutants, atmospheric stability, mixing, and inversions, and smog formation; detailed analysis of emission sources, emission calculation methods, air pollutant dispersion modeling, and equipment and processes to control criteria and toxic pollutants. Indoor air pollutants and radon are included. Prerequisite: MATH 112 or MATH 122 or MATH 131.

CIVL 572 Sustainable Waste Management (3 semester hours)

Overview of the regulatory constraints associated with waste management. Application of current technology in municipal solid waste collection, handling, resource recovery, and safe disposal of residuals including landfill design, operation, gas mitigation, and closure. General characterization of principal industrial wastes, typical treatment processes used for recycling, waste reduction, and safe disposal of residuals. Hazardous waste characterization and minimization, storage, treatment, and residuals disposal; overview of site assessment and remediation strategies. Prerequisite: MATH 112 or MATH 122 or MATH 131.

CIVL 573 Economics of Water and the Environment (3 semester hours)

Local, regional, and international economics are a fundamental component of water resources and environmental systems and associated management and decision making. This course covers topics on the debt-monetary system; debt financing for environmental projects; bond market; discount rate; and cash flow equivalence and benefit-cost analysis for project alternatives, including net present value, internal rate of return and unit cost. Students incorporate cost and interest rate uncertainty in project valuation studies as well as perform cost effective analysis using linear programming and other tools. Case studies include water treatment facilities, water transfers, and other environmentally focused projects. Prerequisites: MATH 131 or MATH 112 or MATH 122.

CIVL 574 Sustainable Engineering (3 semester hours)

Introduction to the role of engineers in sustainability with focus on the modern engineer's role on design. Topics include environmental impacts, economics, climate change, stormwater management, recycled water and desalination, waste management, renewable energy, sustainable building and infrastructure, life cycle assessment, and green rating systems for engineering. Prerequisite: MATH 112 or MATH 122 or MATH 131.

CIVL 575 Renewable Energy Systems (3 semester hours)

A detailed study of alternative energy technologies including: solar thermal, solar photovoltaic, wind, fuel cells, and geothermal systems will be covered. In-depth analysis of the technical aspects of these systems will be covered while considering economic and environmental constraints. Energy storage and grid integration will also be considered. Senior or graduate standing required. Majors only.

CIVL 576 Project Management (3 semester hours)

This course will integrate project management theory with practical approaches to establish a fundamental knowledge base for use in today's contemporary dynamic business environment. Project management will be explored from planning and selection through all aspects of the project life cycle. Practical techniques will be developed to organize and control non-routine activities in order to properly manage schedule, quality, budget, and performance objectives. The course will concentrate on project management areas identified as core knowledge areas by the Project Management Institute (PMI). The areas include the management of: Project Integration, Scope containment, Time, Cost, Quality, Human Resources, Procurement, and Risk. Senior or Graduate Standing Required. Majors Only.

CIVL 577 Transportation Engineering (3 semester hours)

This class introduces basic concepts involved in the broad and important field of transportation engineering. It focuses on passenger transportation, specifically highways and urban public transit. It addresses the characteristics of included modes, basic design of their guideways and stations, selection of appropriate street designs or modes for given applications, conducting trip generation and parking generation studies, and performing demand/capacity analyses. The history of urban transportation, transportation financing, traffic engineering, and transit operations planning is also covered. By the end of the course, students will have a strong basis for continuing their studies in the field and/or will simply be better informed on transportation issues as they inevitably arise in life. Juniors and seniors only.

CIVL 578 Research in Civil Engineering & Environmental Science (3 semester hours)

This course is designed to provide undergraduates and graduate students with research opportunities and better prepare undergraduates for advanced degrees. Students perform research in accordance with the scientific methodology in areas civil engineering, environmental engineering, and/or environmental science under the supervision of a research advisor who may or may not be the primary course instructor. The precise research topic is selected together by each student and/or advisor. Topics include the research process; hypothesis formulation and testing; modern scientific research; relevant research topics; analysis of scientific articles; data interpretation; critical assessment of public opinion versus scientific evidence; and article, report, and presentation preparation. Permission of instructor required.

CIVL 591 FE/EIT Environmental Preparation (1 semester hour)

The Fundamentals of Engineering exam and Engineer-in-Training is the first step in becoming a licensed Professional Environmental Engineer. This course provides preparation for the National /Council of Examiners for Engineering and Surveying (NCEES) discipline-specific Environmental FE exam with emphasis on water distribution, wastewater collection, treatment, health risk, noise, air quality, fate and transport, and landfills. The FE reference handbook is used in the solution of practice problems. Credit/No Credit only.

CIVL 592 FE/EIT Other Disciplines (General) Preparation (1 semester hour)

The Fundamentals of Engineering exam and Engineer-in-Training is the first step in becoming a licensed Professional Engineer. This course provides preparation for the National Council of Examiners for Engineering and Surveying (NCEES) general non-discipline specific (other disciplines) FE exam. Credit/No Credit only.

CIVL 598 Special Studies (1-4 semester hours)**CIVL 599 Independent Studies (1-4 semester hours)****CIVL 600 Comprehensive Exam (0 semester hours)**

Students must register for this class but only after they have completed all of their course requirements (30 semester hours) or will have completed all of their course requirements at the end of the semester in which they plan to take the comprehensive examination.

CIVL 601 Sustainable Water Quality and Resources (3 semester hours)

This course introduces fundamental water quality and resources topics in the context of sustainability. Topics include introductions to aquatic interactions and fates of pollutants in natural environments; watershed protection and stormwater management for surface and groundwater supplies; sustainable management of groundwater supplies; recycled water production and uses; water quality; and water and wastewater treatment systems.

CIVL 605 Aquatic Chemistry (3 semester hours)

Review of stoichiometry, oxidation-reduction reactions, thermodynamics, and chemical kinetics. Equilibrium chemistry concepts including acid-base, gas, and solid-liquid equilibria applied to aquatic systems with an emphasis on problem-solving methods to determine chemical speciation and pH effects in natural and treated aquatic systems.

CIVL 608 Contaminant Fate, Transport, and Remediation (3 semester hours)

Introduction to physical, chemical, and biological processes governing the movement and fate of contaminants in the surface and coastal water environment. Practical quantitative problems solved based on contaminant mass transport, equilibrium partitioning, and chemical transformations in the environment. Regulatory implications and remediation approaches. Prerequisite: CIVL 601 or ENVS 605.

CIVL 610 Water Treatment Systems (3 semester hours)

Integration of unit processes and operations and functional engineering design of water treatment systems. Prerequisite: CIVL 640.

CIVL 612 Adv Integ Water Trtmt Systems (3 semester hours)

Detailed analysis of emission sources, emission calculation methods, and air pollution controls. The dispersion of air pollutants in the atmosphere (fates and lifetimes, dispersion modeling methods). In-depth techniques of conducting risk assessments due to exposure to air pollutants.

CIVL 617 Water Treatment Processes (3 semester hours)

Theory and practice of the physical and chemical treatment processes to treat water and wastewater including reactor performance, screening sedimentation, membrane and media filtration, adsorption, ion exchange, disinfection. Theory and practice of biological treatment of wastewater including activated sludge, attached growth systems, oxygen transfer, secondary clarification, nutrient removal, residuals stabilization and dewatering, natural treatment systems. Prerequisite: CIVL 601. Corequisites: CIVL 605 and ENVS 606.

CIVL 618 Water Reuse and Desalination (3 semester hours)

Wastewater reuse and desalination are key components of future water supply systems. This course covers processes used for water reuse and membrane treatment systems. The objectives include understanding: 1) the rapidly expanding wastewater reuse market; 2) advanced treatment processes required for reuse; and 3) the roles and characteristics of membrane systems for treatment of water and wastewater along with desalination for seawater and brackish water. Existing reuse and membrane treatment systems are studied to understand how individual processes are integrated to meet the water quality objectives and treatment requirements for different applications. Prerequisite: CIVL 601.

CIVL 619 Advanced Integrated Water Treatment Systems (3 semester hours)

Integrated design of water and wastewater treatment facilities from site and process selection, site layout, hydraulics, flow and material balances, pumping, odor control, and chemical feed systems. Includes the design of additional processes such as ozonation, air stripper, ion exchange, adsorption, nutrient removal, etc. Prerequisite: CIVL 617.

CIVL 620 Computers and Environmental Analysis (3 semester hours)

Applications of digital simulations in the analysis of problems in the environment, water quality modeling, numerical methods, statistical analysis, and use of a large scale application program.

CIVL 625 Applied Fluid Mechanics (3 semester hours)

Fundamentals of fluid mechanics, and review of the underlying mathematical principles, viscosity, fluid statics, conservation of mass, energy equation, momentum principle, fluid flow in pipes, hydraulic machinery. Open to science majors interested in a master's degree in environmental science. Permission of instructor required.

CIVL 626 Surface Water Hydrology (3 semester hours)

Applications of digital simulations in the analysis of problems in the environment, water quality modeling, numerical methods, statistical analysis, and use of a large scale application program.

CIVL 627 Urban Water Systems and Stormwater Management (3 semester hours)

Overview of the theory and practical applied hydraulic design in an urban setting. Topics include potable water conveyance facilities with pump stations and reservoirs; storm water conveyance systems including pipe, street gutter, storm drains, and culverts. Emphasis is placed on the design Low Impact Development (LID) bioretention, and other facilities for regulatory compliance and sustainability, as well as on the application of modeling software used in practice. Prerequisite: CIVL 625.

CIVL 628 Groundwater Hydrology and Sustainable Management (3 semester hours)

Groundwater in California and other regions of the world is a critical component of our water supply portfolio, and proper management requires a judicious balance between municipal, agricultural, and environmental interests. In this course, students will learn about 1) the theory of groundwater occurrence and movement; 2) the engineering involved in groundwater extraction, replenishment, and protection; and 3) sustainable basin management strategies and optimization techniques. Specific course topics include theory of the movement and occurrence of water in a porous medium, Darcy's law, steady and unsteady flow in confined and unconfined aquifers, hydraulics of groundwater wells, municipal water well design, use of professional groundwater modeling software, optimization techniques to sustainably manage groundwater basin pumping, safe yield operation, artificial recharge, conjunctive use of groundwater and surface water supplies, seawater intrusion prevention, and sustainable basin management strategies and agreements. Prerequisite: CIVL 625.

CIVL 629 Groundwater Contaminant Transport and Remediation (3 semester hours)

Processes affecting the transport and fate of inorganic and organic contaminants in groundwater. Emphasis is placed on processes involving phase equilibrium, mass transfer, dissolution, etc. Review of flow and contaminant transport models, remediation technologies, and practical/regulatory considerations. Prerequisite: CIVL 628.

CIVL 630 Design of Concrete Structures (3 semester hours)

Theory and design of reinforced concrete columns, beams, retaining walls, footings, and slabs. Application to design projects.

CIVL 632 Design of Steel Structures (3 semester hours)

Fundamentals of load and resistance factor design of steel components, connections, and systems. Component designs include beams, composite beams, beam columns, tension and compression members, and simple connections. Introduction to computational modeling.

CIVL 633 Design of Wood Structures (3 semester hours)

The course addresses properties and behavior of wood products, design criteria using structural timber, glue laminated lumber, and panels, LRFD design of bending and compression members, frames, diaphragms, shear panels, and connection details, and use of resources such as building codes and the National Design Specifications.

CIVL 635 Contaminant Transport in Groundwater (3 semester hours)

Processes affecting the transport and fate of inorganic and organic contaminants in groundwater. Emphasis is placed on processes involving phase equilibrium, mass transfer, dissolution, etc. Review of flow and contaminant transport models, remediation technologies, and practical/regulatory considerations. Prerequisites: CIVL 514, ENVS 631, and ENVS 633.

CIVL 636 Nonlinear Structural Analysis (3 semester hours)

This course will cover nonlinear response and behavior of new and retrofitted buildings to earthquake ground motions. The course will be taught with lectures and projects (Perform 3D), using both prescriptive and performance-based design methodologies. Topics include nonlinear static and dynamic analysis, response spectra, component and system behavior, damping, latest research references for computational modeling.

CIVL 637 Building Information Modeling (3 semester hours)

This course focuses on the knowledge and skills required to create and utilize a Building Information Model (BIM) for construction building projects. This is a project-based course where students apply BIM concepts to real-life projects from the planning and design stages to the construction phase. The course also introduces the use of BIM for clash detection as well as for cost estimating and scheduling purposes. Graduate standing required.

CIVL 638 Construction Management and Sustainability (3 semester hours)

Course provides students with an introduction to construction management and sustainable building practices and rating systems including CALGreen and Leadership in Energy and Environmental Design (LEED).

CIVL 639 Design of Masonry Structures (3 semester hours)**CIVL 640 Physical and Chemical Treatment Processes (3 semester hours)**

Theory and practice of the physical and chemical treatment processes to treat water and wastewater including flow equalization, preliminary treatment, grit removal, primary sedimentation, filtration, floatation, adsorption, ion exchange and membrane separation, air stripping, precipitation, chemical oxidation and disinfection. Prerequisites: CIVL 310 or 504 or equivalent; ENVS 631 and 633.

CIVL 641 Biological Treatment Processes (3 semester hours)

Theory and practice of biological treatment of wastewater and wastewater residuals including activated sludge, biotower and fixed film systems, oxygen transfer, secondary clarification, nutrient removal, aerobic and anaerobic digestion, composting, oxidation ponds, and wetlands. Prerequisites: CIVL 310 or 504 or equivalent; ENVS 631, 633, and 644.

CIVL 646 Geotechnical Earthquake Engineering (3 semester hours)

Introduction to engineering seismology and earthquake ground motions. Evaluation of dynamic soil properties, seismic site response analysis, soil liquefaction evaluation and mitigation, seismic slope stability, and seismic evaluation of dams and embankments. Prerequisite: CIVL 410 or ENVS 652.

CIVL 647 Dams and Levees (3 semester hours)

Evaluation of geotechnical, hydrology, and hydraulic components for the design and evaluation of dam and levee structures. Consideration of unconfined groundwater flow, filter design, embankment stability, open channels, and other related topics. Prerequisites: CIVL 620 and permission of the instructor.

CIVL 650 Fundamentals of Environmental Health Risk Assessment (2 semester hours)

The fundamental technical aspects and non-technical policy aspects of environmental health risk assessments. Basics of environmental chemistry; partitioning, fate and transport of pollutants in the atmosphere and water; human exposure scenarios, fundamentals of toxicology and epidemiology.

CIVL 651 Remote Sensing with Civil Engineering and Environmental Science Applications (3 semester hours)

The course introduces the fundamental concepts of remote sensing from space, remote sensing data, and image data processing. Topics include characteristics of electromagnetic spectrum and remote sensing devices, digital processing methods for interpreting, manipulating and analyzing remotely-sensed image data, and applications of satellite remote sensing to civil engineering and environmental fields.

CIVL 653 Modeling Environmental and Water Resources Systems (3 semester hours)

This course provides an introduction to mathematical modeling techniques used to solve and interpret a variety of environmental and water resources engineering problems. Topics include numerical solution of ordinary and partial differential equations, optimization, and statistical analysis of model results. Prerequisite: CIVL 625.

CIVL 655 Computational Fluid Dynamics (3 semester hours)

In-depth study of applied computational methods for solving problems involving fluid and heat transport. Course will include both commercially available codes as well as self-generated solving routines. Topics include: numerical solutions to PDEs, steady flow solutions, unsteady flow solutions, flows involving heat transfer. Prerequisite: CIVL 505 or 605. Graduate standing required.

CIVL 657 Finite Element Methods (3 semester hours)

Introduction to the theory and application of finite element methods. Review of the fundamentals of analytical models, elasticity, and structural mechanics. Review of matrix theory and calculation of variations. General process for the development of a finite element solution. Derivations of basic elements, including those for trusses, plane stress and plane strain, beams, plates, and solids. Discussion of the issues of conformity and completeness. Higher order interpolation functions and isoparametric elements. Solutions and applications to problems in structural mechanics, heat transfer, structural dynamics, and elastic stability. Practical examples. Graduate standing required.

CIVL 670 Contracts and Specifications (2 semester hours)

Discussion of the design and construction process, contract documents and specifications, contract changes, claims and disputes, property issues, selection of the design professional and professional service contracts.

CIVL 671 Air Quality, Control, and Management (3 semester hours)

Air pollution effects, and principal regulations, including greenhouse gases and environmental justice, emission standards, criteria and toxic pollutants, atmospheric stability, mixing, and inversions, and smog formation; detailed analysis of emission sources, emission calculation methods, air pollutant dispersion modeling, and equipment and processes to control criteria and toxic pollutants. Indoor air pollutants and radon are included.

CIVL 672 Sustainable Waste Management (3 semester hours)

Overview of the regulatory constraints associated with waste management. Application of current technology in municipal solid waste collection, handling, resource recovery, and safe disposal of residuals including landfill design, operation, gas mitigation, and closure. General characterization of principal industrial wastes, typical treatment processes used for recycling, waste reduction, and safe disposal of residuals. Hazardous waste characterization and minimization, storage, treatment, and residuals disposal; overview of site assessment and remediation strategies.

CIVL 673 Economics of Water and the Environment (3 semester hours)

Local, regional, and international economics are a fundamental component of water resources and environmental systems and associated management and decision making. This course covers topics on the debt-monetary system; debt financing for environmental projects; bond market; discount rate; and cash flow equivalence and benefit-cost analysis for project alternatives, including net present value, internal rate of return and unit cost. Students incorporate cost and interest rate uncertainty in project valuation studies as well as perform cost effective analysis using linear programming and other tools. Case studies include water treatment facilities, water transfers, and other environmentally focused projects.

CIVL 674 Sustainable Engineering (3 semester hours)

Introduction to the role of engineers in sustainability with focus on the modern engineer's role on design. Topics include environmental impacts, economics, climate change, stormwater management, recycled water and desalination, waste management, renewable energy, sustainable building and infrastructure, life cycle assessment, and green rating systems for engineering.

CIVL 675 Renewable Energy Systems (3 semester hours)

A detailed study of alternative energy technologies including: solar thermal, solar photovoltaic, wind, fuel cells, and geothermal systems will be covered. In-depth analysis of the technical aspects of these systems will be covered while considering economic and environmental constraints. Energy storage and grid integration will also be considered. Graduate standing required.

CIVL 676 Project Management (3 semester hours)

This course will integrate project management theory with practical approaches to establish a fundamental knowledge base for use in today's contemporary dynamic business environment. Project management will be explored from planning and selection through all aspects of the project life cycle. Practical techniques will be developed to organize and control non-routine activities in order to properly manage schedule, quality, budget, and performance objectives. The course will concentrate on project management areas identified as core knowledge areas by the Project Management Institute (PMI). The areas include the management of: Project Integration, Scope containment, Time, Cost, Quality, Human Resources, Procurement, and Risk. Graduate Standing Required.

CIVL 677 Transportation Engineering (3 semester hours)

This class introduces basic concepts involved in the broad and important field of transportation engineering. It focuses on passenger transportation, specifically highways and urban public transit. It addresses the characteristics of included modes, basic design of their guideways and stations, selection of appropriate street designs or modes for given applications, conducting trip generation and parking generation studies, and performing demand/capacity analyses. The history of urban transportation, transportation financing, traffic engineering, and transit operations planning is also covered. By the end of the course, students will have a strong basis for continuing their studies in the field and/or will simply be better informed on transportation issues as they inevitably arise in life.

CIVL 678 Research in Civil Engineering & Environmental Science (3 semester hours)

This course is designed to provide undergraduates and graduate students with research opportunities and better prepare undergraduates for advanced degrees. Students perform research in accordance with the scientific methodology in areas civil engineering, environmental engineering, and/or environmental science under the supervision of a research advisor who may or may not be the primary course instructor. The precise research topic is selected together by each student and/or advisor. Topics include the research process; hypothesis formulation and testing; modern scientific research; relevant research topics; analysis of scientific articles; data interpretation; critical assessment of public opinion versus scientific evidence; and article, report, and presentation preparation. Permission of instructor required.

CIVL 690 Comprehensive Oral Exam (0 semester hours)

The oral examination provides an opportunity to assess the student's understanding of some of the fundamental principles of environmental engineering, water resources engineering, and/or environmental science. It provides an opportunity for the student to demonstrate her/his problem-solving abilities using knowledge learned through coursework and an indication of student accomplishment broader than what is obtained from conventional classroom assessment. The exam is generally offered on the Friday of final examinations week. Students can register for the class only if all of course requirements will be complete at the end of the semester in which they plan to take the exam. Students with non-engineering undergraduate degrees must also pass the Fundamentals of Engineering Exam overseen by National Council of Examiners for Engineering and Surveying. Credit/No Credit only.

CIVL 691 FE/EIT Environmental Preparation (1 semester hour)

The Fundamentals of Engineering exam and Engineer-in-Training is the first step in becoming a licensed Professional Environmental Engineer. This course provides preparation for the National Council of Examiners for Engineering and Surveying (NCEES) discipline-specific Environmental FE exam with emphasis on water distribution, wastewater collection, treatment, health risk, noise, air quality, fate and transport, and landfills. The FE reference handbook is used in the solution of practice problems. Credit/No Credit only.

CIVL 692 FE/EIT Other Disciplines (General) Preparation (1 semester hour)

The Fundamentals of Engineering exam and Engineer-in-Training is the first step in becoming a licensed Professional Engineer. This course provides preparation for the National Council of Examiners for Engineering and Surveying (NCEES) general non-discipline specific (other disciplines) FE exam. Credit/No Credit only.

CIVL 695 Master Thesis (3 semester hours)

Master Thesis

CIVL 696 Thesis Defense (0 semester hours)

Students who opt for a thesis must defend their research to a thesis committee in the form of a written thesis and an oral presentation. It is the intent of the thesis committee to determine if the student 1) has mastered the subject matter of the thesis, 2) understands the work done by others, and 3) can critically assess that work and his/her own work. No later than two weeks prior to the thesis defense presentation, the student must provide their written thesis to their thesis committee for review. The presentation should take no longer than one hour, including questions and answers from the committee and audience. Immediately after the presentation, the committee will deem the thesis complete, complete with exceptions, or incomplete. Credit/No Credit only.

CIVL 698 Special Studies (1-4 semester hours)**CIVL 699 Independent Studies (1-4 semester hours)**

Independent Studies

CIVL 2200 Engineering Thermodynamics (2 semester hours)

Fundamental of classic thermodynamics, properties of pure substances, ideal gas laws and climate variables, work, heat, energy balances for closed and open systems, second law, entropy, irreversible processes, isentropic processes, power, and refrigeration cycles. Prerequisite: CHEM 114, MATH 132

CIVL 2300 Mechanics of Materials (4 semester hours)

Development of relationships between loads applied to a nonrigid body including axial and torsional loading and the resulting stresses and deformations in the body, the relation between stresses and strains, develop adequate procedures for finding necessary dimensions of a member with respect material capabilities and design constraints. Topics include Torsion, Bending, Stability of Columns, analysis of bolted or welded joints. Prerequisite: ENGR 200.

CIVL 2500 Surveying and Mapping (4 semester hours)

Study and utilization of state-of-the-art surveying instruments and related computations for topographic surveys, horizontal and vertical curves, and the design of highways. Introduction to computer aided design and geographic information systems (applications of Autodesk Civil 3D to civil engineering design and fundamentals of GIS using ArcView). Prerequisite: Sophomore standing Lecture, 2 hours; Laboratory, 4 hours.

CIVL 3040 Probability and Statistics in Civil and Environmental Engineering (2 semester hours)

Introduction to probability and statistics with an emphasis on techniques and applications useful in engineering. Prerequisite: MATH 132.

CIVL 3100 Fluid Mechanics (4 semester hours)

Properties of fluids, fluid statics, kinematics, energy, hydrodynamics, momentum and dynamic forces, steady flow of compressible and incompressible fluids. Course includes a Fluids Lab component. Prerequisites: CIVL 2200, MATH 234, and MATH 245 or concurrent enrollment.

CIVL 3150 Hydrology and Water Resources Engineering (4 semester hours)

Flood control hydrology including rainfall runoff methods of analysis, unit hydrographs, flood routing, flood frequency analysis. Development of surface and groundwater supplies, reservoir yield and operation, determination of water requirements, analysis of water supply and distribution systems. Risk & reliability statistics. Analysis of pumps. Hands-on fluid lab experiments with pumps and open channels. Prerequisites: MATH 246, CIVL 3100 and, CIVL 3400 or MATH 360.

CIVL 3200 Introduction to Sustainability & Environmental Engineering (4 semester hours)

Introduction to sustainability and environmental engineering principles. Topics will include water and wastewater treatment processes; solid waste management; air pollution; sustainable water resource and pollution management in natural and urban environments; renewable energy. Integrated laboratory demonstrations are included. Lecture, 4 hours. University Core fulfilled: Explorations: Nature of Science, Technology, and Mathematics (Civil Engineering majors only). Prerequisites: BIOL 114, CHEM 114, MATH 132, and MATH 246 or concurrent enrollment.

CIVL 3350 Structural Analysis and Design (4 semester hours)

Analysis of determinate and indeterminate deformable structures at the element and system level using classical methods, and an introduction to computer methods of analysis to develop design skills. Introduction to the International Building Code. Prerequisites: CIVL 2300 and MATH 246.

CIVL 3360 Structural Dynamics and Seismic Systems (4 semester hours)

Brief review of particle dynamics. Introduction to fundamentals of structural dynamics through theory and lab. Free and forced vibration of discrete and multiple degree of freedom systems, continuous systems, design for earthquake loading, application of the Uniform Building Code to the seismic design of structures. Structural dynamics experiments will be conducted. Prerequisites: CIVL 2300 and MATH 246.

CIVL 3400 Analytical Methods in Civil and Environmental Engineering (2 semester hours)

Introduction to probability and statistics with an emphasis on techniques and applications useful in engineering. Prerequisite: MATH 132.

CIVL 3410 Introduction to Geotechnical Engineering (4 semester hours)

Soil formation, classification, physical and mechanical properties, soil compaction, flow through porous media, effective stress, earth pressures, consolidation, shear strength, and application to design of foundations and earth structures. Laboratory testing of soils. Prerequisites: CIVL 2300, CIVL 3100.

CIVL 4001 Civil Engineering Design, Practice, and Ethics (4 semester hours)

An integrated senior design experience which utilizes knowledge from the civil engineering curriculum. In addition to the technical aspects, the designs consider costs, sustainability economics, and environmental factors. Class lectures include discussion of the design process, environmental impact, engineering and professional ethics, the engineering profession, professional practice issues, the role of the engineer in the construction process, and procurement of engineering work. Student project reports and presentations are required. Prerequisites: CIVL 2100, CIVL 3150, CIVL 3200, CIVL 3350, CIVL 3360, CIVL 3410, CIVL 395, Senior standing required.

CIVL 4900 Fundamentals of Engineering Exam Review (0 semester hours)

Topics for the Fundamentals of Engineering examination will be reviewed. The review will include sample test questions.