

## MASTER OF CIVIL ENGINEERING

The AUA Master's degree program is based upon MIT syllabi and curricula and the European professional requirements for chartered Civil Engineers.

The Master of Science in Civil Engineering degree program may be earned in one of the following specializations:

General Civil Engineering  
Transportation Systems  
Structural Analysis  
Geotechnical Engineering  
Project Management  
Concrete and Materials Engineering

Geotechnical Engineering  
EK 5501

EK 6361	DGE
EK 6158	7233
EK 6321	DGE
EK 6364	DGE 7213
EK 6954	DGE 7217
	DGE 7218
	DGE 6203

Project Management

EK 6040  
EK 6936  
EK 6954  
EK 6135  
EK 6094

General Civil Engineering  
Five Courses

EK 5501	EK 6005	DGE 7225
EK 5502	EK 6506	DGE 7924
EK 5510	EK 6508	DGE 6206
	ME 5828	MA 6202
	ME 5832	
	ME 6914	

3 Electives

### Transportation Systems

EK 5501	EK 6225	EK 6259
EK 5502	EK 6224	EK 6258
EK 5510	EK 6622	EK 6221
		EK 6223

### Structural Analysis

EK 5501	EK 6158	EK 6080
EK 5502	EK 6138	EK 6571
EK 5510	EK 6622	EK 6954
ME 6914		EK 6037
ME 5828		
ME 5832		
EK 6005		
EK 6504		
EK 6506		
EK 6508		

### Concrete and Materials

EK 6158	EK 6955
EK 6138	EK 6037
EK 6622	
EK 6080	

## THE AMERICAN UNIVERSITY OF ATHENS

### BACHELOR'S – MASTER'S – PH.D. IN CIVIL ENGINEERING

Civil Engineering is the original of the engineering disciplines. With the increase in population, the growing complexity of industries, and changing urban centers, the civil engineer's task-applying science to the control and utilization of the environment for the total benefit of mankind represents a challenge unsurpassed in all of engineering.

The civil engineer often is confronted with conditions so variable and complex that they cannot be precisely defined by science and mathematics. Therefore, a knowledge of the arts and social sciences, as well as the physical sciences, is essential. In addition, because civil engineering requires overall planning of very large projects whose components involve many other disciplines, it is also necessary to have knowledge of management techniques. The goal of the civil engineering degree program is to provide an education that enables graduates to make far-reaching decisions that draw not only from technical knowledge but also from integrity and judgment.

In the professional courses, classroom lectures are supplemented by laboratory practice, including the study of materials, concrete, hydraulics, environmental engineering, geotechnical engineering, and surveying. The principal functional areas that are considered subdivisions of civil engineering are structural engineering, transportation engineering, geotechnical engineering, environmental engineering, water resources engineering, and construction management.

The options of Civil and Architectural Engineering provide introductory undergraduate education in these six subdisciplines of civil engineering and provide professional specializations in the areas of structural, geotechnical, transportation, civil-environmental, construction engineering and architectural engineering.

#### **Required Courses** (26-28 semester credit hours)

EK 3131	Structural Theory I
EK 3132	Structural Theory II
EK 3168	Introduction to Geotechnical Engineering
EK 3305	Mechanics of Materials
EK 4191	Metal Structures
EK 4192	Reinforced Concrete Structures
EK 4193	Hydraulics
EK 4196	Design and Cost Analysis of Civil Engineering Structures
EK 4198	Research

**Required Courses for the Engineering Division** (61 semester credit hours) Refer to page 72.

**General Education Requirements** (39 semester credit hours) Refer to page 32.

**General Electives** (6 semester credit hours)

Total of one hundred thirty-two to one hundred thirty-four (132-134) semester credit hours.

#### **PREREQUISITES**

Basic knowledge of engineering. If the students have no prior knowledge then there is a need for extra courses from the undergraduate level.

To receive an MS in engineering, students must take the following non-credit seminars during the first semester:

CIS 5000	Computer Basics
EN 5000	Academic Writing
MA 5000	Mathematics Basics
RM 5000	Research Methodology

### **GRADUATION REQUIREMENTS**

Students must complete 40 credit hours with the following distribution:

- 1) The successful completion of 28-32 credit hours of courses that fall within the specialization areas or within the general engineering courses.
- 2) Submission of a thesis of 15,000 - 30,000 words with 8-12 credit hours.

### **MASTER'S THESIS REQUIREMENTS**

Students must fulfill the following requirements:

- 1) Complete at least 8 credits of graduate coursework with an overall GPA of 3.0 or above and no more than two class grades below "B".
- 2) Complete and defend a Master's thesis proposal by a two-person committee (the Chairman and the supervisor).
- 3) Complete and defend a Master's thesis that counts for 8-12 credit hours.
- 4) The Master's thesis must demonstrate the student's ability to effectively communicate in writing the results of a graduate study. Students are expected to prepare a thesis, which integrates the knowledge they acquired with original research. They are expected to choose a topic that captures the latest developments in the engineering field and to carry out primary and secondary data collection in this area, use scientific methods for analysis of data and then produce a professional report which constitutes original work. Students work on this project with the close supervision of assigned professors depending on the area of specialization.
- 5) The student has to defend the thesis in front of a three-person committee, which includes two instructors in the same field and one from another department.

### **SPECIALIZATIONS OFFERED**

The School offers three specialization areas which respond to the contemporary demands of today's world. Students have to take at least four courses within the specific specialization to satisfy the requirements. Students can take a fifth course if they wish to prepare an 8-credit thesis rather than a 12-credit one. The specialization areas offered by CSE are:

- General Engineering and Applied Sciences
- Mechanical Engineering (fluid mechanics, dynamics and controls, materials)

- Computer Systems Engineering (signal processing and communication, systems and controls, computer communications and networks, software engineering)

### **CORE COURSES**

For each specialization of the Master of Science there are no core courses, students select from the courses listed within the specialization areas.

### **EK 6133      CONCEPTS OF CIVIL ENGINEERING PRACTICE**

The course is designed to teach students about the roles of today's professional engineer and to expose them to team-building skills through lectures, team workshops, and seminars. Topics include: written and oral communications, job placement skills, trends in the engineering and construction industry, proposal preparation, project evaluation, project management, professional ethics, and negotiation. The course draws on relevant large scale projects to illustrate each component of the subject.

### **EK 6094      SYSTEM OPTIMIZATION MODEL AND COMPUTATION**

This class is an applications-oriented course covering the modeling of large-scale systems in decision-making domains and the optimization of such systems using state-of-the-art optimization tools. Application domains include: transportation and logistic planning, pattern classification and image processing, data mining, design of structures, scheduling in large systems, supply-chain management, financial engineering, and telecommunications systems planning. Modeling tools and techniques include linear, network, discrete and nonlinear optimization, heuristic methods, sensitivity and post-optimality analysis, decomposition methods for large-scale systems, and stochastic optimization.

### **EK 6212      INTRODUCTION TO INTELLIGENT TRANSPORTATION SYSTEMS**

Intelligent Transportation Systems (ITS) represent a major transition in transportation on many dimensions. This course considers ITS as a lens through which one can view many transportation and societal issues. ITS is an international program intended to improve the effectiveness and efficiency of surface transportation systems through advanced technologies in information systems, communications, and sensors. In the United States, ITS represents the major post-Interstate-era program for advancing surface transportation in highways and public transportation, and is potentially comparable to the air traffic control system in impact.

### **EK 6221      TRANSPORTATION SYSTEMS**

This course strives to be an interdisciplinary systems subject in the "open" sense. It introduces qualitative modeling ideas and various techniques and philosophies of modeling complex transportation enterprises. It also introduces conceptual frameworks for qualitative analysis, such as frameworks for regional strategic planning, institutional change analysis, and new technology development and deployment. And it covers transportation as a large-scale, integrated system that interacts directly with the social, political, and economic aspects of contemporary society. Fundamental elements and issues shaping traveler and freight transportation systems are covered, along with underlying principles governing transportation planning, investment, operations, and maintenance.

## **EK 6623      TRANSPORTATION      POLICY,      STRATEGY      AND MANAGEMENT**

This class surveys the current concepts, theories, and issues in strategic management of transportation organizations. It provides transportation logistics and engineering systems students with an overview of the operating context, leadership challenges, strategies, and management tools that are used in today's public and private transportation organizations. The following concepts, tools, and issues are presented in both public and private sector cases: alternative models of decision-making, strategic planning (e.g., use of SWOT analysis and scenario development), stakeholder valuation and analysis, government-based regulation and cooperation within the transportation enterprise, disaster communications, systems safety, change management, and the impact of globalization.

## **EK 6361      ADVANCED SOIL MECHANICS**

This class presents the application of principles of soil mechanics. It considers the following topics: the origin and nature of soils; soil classification; the effective stress principle; hydraulic conductivity and seepage; stress-strain-strength behavior of cohesionless and cohesive soils and application to lateral earth stresses; bearing capacity and slope stability; consolidation theory and settlement analyses; and laboratory and field methods for evaluation of soil properties in design practice.

## **EK 6040      PROJECT MANAGEMENT**

This course covers three important aspects of construction project management: the theory methods and quantitative tools used to effectively plan, organize, and control construction projects; efficient management methods revealed through practice and research and hands-on, practical project management, knowledge from on-site situations and field trips. The course relies in a basic project management framework in which the project life-cycle is broken into organizing, planning, monitoring, controlling and learning from old and current construction projects. Within the framework, students learn the methodologies and tools necessary for each aspect of the process as well as the theories upon which these are built. By the end of the semester they are able to adapt and apply the framework to effectively manage a construction project in an Architecture/Engineering/Construction (A/E/C) organization.

## **EK 6225      TRANSPORTATION FLOW SYSTEMS**

Design, operation, and management of traffic flows over complex transportation networks are the foci of this course. It covers two major topics: traffic flow modeling and traffic flow operations. Sub-topics include deterministic and probabilistic models, elements of queuing theory, and traffic assignment. Concepts are illustrated through various applications and case studies. This is a half-term subject offered during the second half of the semester.

## **EK 6158      COMPUTATIONAL GEOMETRY**

Topics in surface modeling: b-splines, non-uniform rational b-splines, physically based deformable surfaces, sweeps and generalized cylinders, offsets, blending and filleting surfaces. Non-linear solvers and intersection problems. Solid modeling: constructive solid geometry, boundary representation, non-manifold and mixed-dimension boundary representation models, octrees. Robustness of geometric computations. Interval methods. Finite and boundary element discretization methods for continuum mechanics problems. Scientific visualization. Variational geometry. Tolerances. Inspection methods. Feature representation and recognition. Shape interrogation for design, analysis and manufacturing. Involves analytical and programming assignments.

## **EK 6224      CARRIER SYSTEMS**

Carrier systems involve the design, operation and management of transportation networks, asset, personnel, freight and passengers. In this course, we will present models and tools for analyzing, optimizing, planning, managing and controlling carrier systems.

## **EK 6138      WAVE PROPAGATION**

This course discusses the Linearized theory of wave phenomena in applied mechanics. Examples are chosen from elasticity, acoustics, geophysics, hydrodynamics and other subjects. The topics include: basic concepts, one dimensional reflection and refraction across an interface, mode conversion in elastic waves, diffraction and parabolic approximation, radiation from a line source, surface Rayleigh waves and Love waves in elastic media, waves on the sea surface and internal waves in a stratified fluid and waves in moving media.

## **EK 6622      PATTERN AND RECOGNITION**

Fundamentals of characterizing and recognizing patterns and features of interest in numerical data. Basic tools and theory for signal understanding problems with applications to user modeling, affect recognition, speech recognition and understanding, computer vision, physiological analysis, and more. Decision theory, statistical classification, maximum likelihood and Bayesian estimation, non-parametric methods, unsupervised learning and clustering. Additional topics on machine and human learning from active research.

## **EK 6080      STRUCTURAL MECHANICS**

Fundamental concepts of structural mechanics with applications to marine, civil, and mechanical structures. Residual stresses. Thermal effects. Analysis of beams, columns, tensioned beams, trusses, frames, cables and shafts of general shape and material, including composites. Elastic approximate methods, energy methods, principle of virtual work, introduction to computational structural mechanics. Examples from civil, mechanical, offshore and ship structures.

### **EK 6322 SOIL BEHAVIOR**

This course presents a detailed study of soil properties with emphasis on interpretation of field and laboratory test data and their use in soft-ground construction engineering. Topics to be covered include: consolidation and secondary compression; basic strength principles; stress-strain strength behavior of clays, emphasizing effects of sample disturbance, anisotropy, and strain rate; strength and compression of granular soils; and engineering properties of compacted soils. Some knowledge of field and laboratory testing is assumed for all students.

### **EK 6364 ADVANCED GEOTECHNICAL ENGINEERING**

This course examines characterization and geotechnical aspects of the design and construction of foundation systems. Topics include: site investigation (with emphasis on in situ testing), shallow (footings and raftings) and deep (piles and caissons) foundations, excavation support systems, groundwater control, slope stability, soil improvement (compaction, soil reinforcement, etc.), and construction monitoring.

### **EK 6259 TRANSIT MANAGEMENT**

This course discusses management methods of relevance to public transportation systems. Topics include: Strategic Planning Management, Labor Relations, Maintenance Planning and Administration, Financing, Marketing and Fare Policy, and Management Information and Decision Support Systems. The course shows how these general management tasks are dealt with in the transit industry and presents alternative arrangements for service provision, including different ways of involving the private sector in public transportation.

### **EK 6258 TRANSPORTATION SERVICE AND OPERATIONS PLANNING**

This course describes the evolution and role of urban public transportation modes, systems, and services, focusing on bus and rail. Technological characteristics and their impacts on capacity, service quality, and cost are described. Current practice and new methods for data collection and analysis, performance monitoring, route design, frequency determination, and vehicle and crew scheduling are also discussed. In addition, the effect of pricing policy and service quality on ridership and methods of estimating costs associated with proposed service changes are presented together with means to improve operations through real time intervention.

### **EK 6571 STRUCTURAL ANALYSIS AND CONTROL**

This course uses computer-based methods for the analysis of large-scale structural systems. Topics covered include: modeling strategies for complex structures; application to tall buildings, cable-stayed bridges, and tension structures; introduction to the theory of active structural control; design of classical feedback control systems for civil structures; and simulation studies using customized computer software.

## **EK 6936      SYSTEM AND PROJECT MANAGEMENT**

The objective of this course is to introduce advanced methods and tools of project management in a realistic context such that they can be taken back to the workplace to improve management of development projects. In contrast to traditional courses on the subject we will emphasize scenarios that cannot be fully predicted such as task iterations, unplanned rework, perceived versus actual progress and misalignments between tasks, product architectures and organizations.

## **EK 6954      MECHANICS AND DESIGN OF CONCRETE STRUCTURES**

Topics covered in this course include: Strength and Deformation of Concrete under various States of Stress; Failure Criteria; Concrete Plasticity; Fracture Mechanics Concepts; Fundamental Behavior of Reinforced Concrete Structural Systems and their Members; Basis for Design and Code Constraints; High-performance Concrete Materials and their use in Innovative Design Solutions; Slabs: Yield Line Theory; Behavior Models and Nonlinear Analysis; and Complex Systems: Bridge Structures, Concrete Shells, and Containments.

## **EK 6033      MECHANICS OF MATERIAL SYSTEMS, AN ENERGY APPROACH**

This course provides an introduction to continuum mechanics and material modeling of engineering materials based on first energy principles: deformation and strain; momentum balance, stress and stress states; elasticity and elasticity bounds; plasticity and yield design. The overarching theme is a unified mechanistic language using thermodynamics, which allows understanding, modeling and design of a large range of engineering materials.

# GENERAL ENGINEERING

## COURSE DESCRIPTIONS

### **EK 5500 Probability with Statistical Applications (4 credits)**

A first course in probability and statistics for students with a level of mathematical maturity and experience comparable to that normally found in entering graduate students. Sample spaces, probability measures, random variables, expectation, applications of transform methods, limit theorems, second order statistics, statistical testing, estimation theory, introduction to random processes, stochastic forecasting, communications theory, and decision analysis.

### **EK 5501 Mathematical Methods I: Linear Algebra and Complex Analysis (4 credits)**

Introduction to basic applied mathematics for science and engineering, emphasizing practical methods and unifying geometrical concepts. Topics include linear algebra for real and complex matrices. Quadratic forms, Lagrange multipliers and elementary properties of the rotation group. Vector differential and integral calculus. Complex function theory, singularities and multi-valued functions, contour integration and series expansions. Fourier and Laplace transforms. Elementary methods for solving ordinary linear differential and systems of differential equations with applications to electrical circuits and mechanical structures.

### **EK 5502 Mathematical Methods II: Differential Equations and Numerical Algorithms (4 credits)**

Analytic and computational methods for physical models encountered in science and engineering. Basic elliptic, parabolic and hyperbolic partial differential equations for physical system. Solutions by separation of variables, eigenfunction expansions, Green's function, integral representations and variational methods. Lattice and finite element discretization, linear iterative methods. Matrix inversions. Fast Fourier and wavelet transforms. ODE, phase plane, stability and chaos. Molecular dynamics, integrations and Monte Carlo/Langevin dynamics. Optional project on large scale numerical simulations.

### **EK 5510 Fourier Transforms (4 credits)**

Fourier transform as a tool for solving physical problems. Develops the properties of the Fourier transform and the discrete Fourier transform. These transforms are applied to the analysis of linear systems; sampled signals and systems; digital filtering; solution of partial differential equations, and antenna theory; two-dimensional systems; optics; medical imaging; mechanical systems; and statistics. Recommended for graduates and advanced undergraduates in engineering, physics, astronomy, and psychology.

### **EK 5542 Advanced Fluid Mechanics (4 credits)**

Incompressible fluid flow. Review of control-volume approach to fluids engineering problems, with advanced applications. Differential analysis of fluid motion.

Derivation of full Navier-Stokes, Euler, and Bernoulli equation. Velocity potential and its application to steady 2D flows. Vorticity and vortex motion. Eulerian vs Lagrangian analysis.

**ME 6914 Simulation (4 credits)**

Modeling of discrete event systems and their analysis through simulation. Systems considered include, but are not limited to, manufacturing systems, computer-communication networks and computer systems. Simulating random environments and output analysis in such contexts. A simulation language is introduced and is the main tool for simulation experimentation.

**ME 5828 Optimization Theory and Methods (4 credits)**

Introduction to optimization problems and algorithms emphasizing problem formulation, basic methodologies, and the underlying mathematical structures. Covers classical optimization theory as well as recent advances in the field. Topics include modeling issues and formulations, simplex method, duality theory, sensitivity analysis, large-scale optimization, integer programming, interior-point methods, non-linear programming optimality conditions, gradient methods, and conjugate direction methods. Particular applications are considered and a few case studies covered. In addition to extensive paradigms from production planning and scheduling in manufacturing systems, other illustrative applications include fleet management, air traffic flow management, optimal routing in communication networks, and optimal portfolio selection.

**ME 5832 Mechanical Behavior of Materials (4 credits)**

This course relates mechanical behavior of crystalline materials to processes occurring at microscopic and/or atomic levels. Topics covered include structure of materials and their determination by X-ray diffraction; dislocations and their relationship to plastic deformations and strength of materials; fracture and creep.

**EK 6005 Engineering Analysis (4 credits)**

Mathematical methods in aerospace and mechanical engineering; vectors and tensors; partial differential equations of heat and mass transfer, wave motion and potential theory, classification of second order PDEs; eigenfunction expansions, method of characteristics, Fourier and Laplace transforms; complex variable theory, residue integration, conformal mapping; Green's functions, integral equations, variational methods; perturbation methods for non-linear differential equations.

**EK 6504 Numerical Methods for Engineering (4 credits)**

Survey of numerical methods with examples selected from aerospace and mechanical engineering. Numerical solution of systems of linear and non-linear algebraic equations, interpolation and extrapolation, computation of eigenvalues and eigenvectors, numerical integration, techniques for numerical solution of ordinary differential equations and partial differential equations. Required projects involve extensive student use of computers.

**EK 6506 Statisticomechanical Concepts in Engineering (4 credits)**

Specific prerequisites vary according to topic, but do not extend beyond what is covered in the core courses in the undergraduate curriculum in mechanical engineering. Elementary introduction to selected fundamental concepts in probability, random processes, signal processing, and statistical mechanics with strong emphasis on their applications to aerospace and mechanical engineering. Examples taken from acoustics, mechanics, thermodynamics, and fluid dynamics.

**EK 6508 Advanced Mechanical Behavior of Materials (4 credits)**

Basic concepts of modern materials engineering. Emphasis is placed on understanding the relationships between solid structure and material properties. Thermodynamics, kinetics, statistical mechanics, deformation, and fracture are explored. Covers the concepts that are essential for graduate research in materials science or an allied field.

**DGE 6205 Advanced Strength of Materials (4)**

Deflection of beams using singular functions, unsymmetrical bending of beams, beams on elastic foundation. Beam-column problems, shear center for thin-walled beam cross sections, curved beams. Applications of energy methods, torsion, basic equations for theory of elasticity, thin- and thick-walled cylinders, stress concentration, and failure criteria.

**DGE 6206 Design of Reinforced Concrete Structures (4)**

Structural behavior of reinforced concrete structures, ultimate strength and deformation characteristics; design of structural components including beams, columns, floor slabs, box-type girders; introduction to prestressed concrete; special topics.

**DGE 7208 Advanced Reinforced Concrete Structures (4)**

Conception, analysis, and design of low-rise and high-rise buildings by ultimate-strength methods, precast systems, progressive collapse, earthquake considerations, domes, folded plates, shell-type structures, and special topics.

**DGE 7210 Methods of Structural Analysis (4)**

Modern methods of analysis of statically indeterminate structures, matrix analysis based on flexibility, stiffness, energy and variational methods, substructuring techniques; consideration of plastic collapse of structures; introduction to the finite element method.

**DGE 7211 Design of Metal Structures(4)**

Structural behavior of metal structures, conception and design of advanced structural components and systems, hysteretic behavior, plastic design principles, box-type girders, cable systems, composite girders, and special topics.

**DGE 7213 Reliability Analysis of Engineering Structures (4)**

Probability theory, theory of structural reliability, probabilistic analysis of strength and loads, risk and reliability function, empirical distribution, probability plot. The design service life, method of perturbation, Monte Carlo simulation. Fatigue and fracture, proof testing, inspection and repair-replacement maintenance.

**DGE 7214 Analysis of Plates and Shells (4)**

Bending and stretching of thin elastic plates under loading with various boundary conditions, continuous plates and plates on elastic foundations, theory of folded-plate structures. Theory of curved surfaces; general linear bending theory and its simplification to membrane theory; bending stresses in shells of revolution, shallow-shell theory.

**DGE 7216 Structural Dynamics (4)**

Vibration of continuous systems: membranes, beam plates, and shells; approximate methods of vibration analysis; methods of integral transform; analysis of nonlinear systems; wave propagation.

**DGE 7217 Random Vibration of Structures (4)**

Introduction to random processes, responses of linear structures to stationary and nonstationary random inputs. Structural responses to earthquakes, waves, boundary-layer turbulences, wind loads, etc. Failure analysis of structures under random loads.

**DGE 7218 Structural Design to Resist Natural Hazards (4)**

Prediction of forces due to earthquakes and strong winds; generalized codes; pseudostatic methods for preliminary design; codes based on spectra, energy absorption and ductility; influence of foundations; ground failures; static and aeroelastic effects of strong winds. Design project.

**DGE 7923 Advanced Structural Analysis (4)**

The application of mechanics to the analysis of indeterminate structural forms important to civil and aeronautical engineering, with emphasis on modern structural types. The analysis of fundamental structural forms, including curved beams, arches, rings, thin walled cell-type structures, and members with variable inertia, for stress and deflection by the classical methods. Influence lines for indeterminate structures. Introduction to matrix analysis and vibration of structures.

**DGE 7924    Advanced Steel Design (4)**

An advanced course in steel design using the Load Resistance Factor Design (LRFD). Component design, connections, composite and built-up sections are covered. Design problems involve braced and rigid structures subjected to gravity, wind and seismic loads.

**DGE 7925    Advanced Reinforced Concrete Design (4)**

Further study of concrete design with emphasis on columns with biaxial bending, flat slab theory and design, and the analysis and design of prestressed concrete structural members.

**DGE 7926    Structural Stability (4)**

Elastic buckling of columns, including the effects of initial crookedness and eccentricity. Large deflections of the Euler column. Tangent modulus and double modulus theory. Beam columns and the stability of frameworks and trusses. Torsional buckling of columns and lateral buckling of beams Plate buckling with applications to flange buckling and web crippling of plate girders.

**DGE 7928    Structural Mechanics (4)**

An introduction to the theory of structural mechanics emphasizing the application of energy methods. Application to equilibrium and stability of beams, struts frameworks, rings and plates and the dynamics of rigid and deformable bodies.

**DGE 7220    Continuum Mechanics (4)**

Introduction to the mechanics of continuous media. Tensor calculus; kinematics; stress and stress rate, conservation of mass, conservation of linear and angular momentum, energy balance, second law of thermodynamics; constitutive theory; linear and nonlinear elasticity, Newtonian fluids, micropolar elasticity.

**DGE 7223    Mechanics of Composite Materials (4)**

Stress-strain relationship for orthotropic materials, invariant properties of an orthotropic lamina, biaxial strength theory for an orthotropic lamina. Mechanics of materials approach to stiffness, elasticity approach to stiffness. Classical lamination theory, strength of laminates. Statistical theory of fatigue damage.

**DGE 7227    Introduction to Finite Element Analysis (4)**

Variational formulation of the finite element method. Weighted residual techniques. Computer implementation of the finite element method. Application to problems in heat transfer, stress analysis, fluid flow, and structural analysis.

**DGE 7228    Advanced Finite Element Analysis (4)**

Review of variational formulation of the finite element method. Formulation of various continuum and structural elements. Application to static and dynamic problems in elasticity, plasticity, large deflection, and instability in plates and shells. Recent developments in finite element methods.

**DGE 7232    Geotechnical Engineering (4)**

Principles of soil mechanics applied to the analysis and design of mat foundations, pile foundations, retaining structures including sheeting and bracing systems, and waterfront structures. Foundations on difficult soils and reinforced earth structures.

**DGE 7233    Geotechnical Earthquake Engineering (4)**

Ground motion, wave propagation, foundation isolation, site response analysis, seismic stability of retaining structures, soil structure interaction.

**MA 6201    Numerical Methods in Engineering (4)**

Eigenvalue problems. Numerical solution of systems of equations and ordinary differential equations. Solution techniques for elliptic, parabolic, and hyperbolic partial differential equations. Numerical methods for solving finite element equations. Introduction to solution of fluid-flow problems.

**MA 6202    Application of Probability Methods in Civil Engineering (4)**

Uncertainty in real-world information; basic probability concepts and models; random variables; useful probability distributions, statistical estimation of distribution parameters from observed data; empirical determination of distribution models; testing hypothesis; regression and correlation analyses; decision theory.

**SPECIALIZATION 1 –General Engineering**

EK	5500	Probability with Statistical Applications
EK	5501	Mathematical Methods I: Linear Algebra and Complex Analysis
EK	5502	Mathematical Methods II: Differential Equations and Numerical Algorithms
EK	5510	Fourier Transforms
EK	5542	Advanced Fluid Mechanics
EK	6005	Engineering Analysis
EK	6504	Numerical Methods for Engineering
EK	6508	Advanced Mechanical Behavior of Materials
EK	6519	Theory of Heat Transfer
EK	6541	Classical Thermodynamics

### **SPECIALIZATION 2 – Mechanical Engineering**

ME 5828	Optimization Theory and Methods
ME 5829	Thermodynamics and Kinetics of Materials and Processes
ME 5830	Materials and Processes in Manufacturing
ME 5831	Phase Transformations
ME 5832	Mechanical Behavior of Materials
ME 5907	Process Modeling and Control
ME 6909	Process Control
ME 6913	Product Development
ME 6914	Simulation

### **SPECIALIZATION 3 – Computer Systems Engineering**

CS 5904	Advanced Data Structure
CS 5908	Process Control
EK 5660	Introduction to Photonics
EK 5663	Fiber-optic Communication Systems
EK 5665	Electromagnetic Energy Transmission
EK 5911	Software Systems Design
EK 5916	Digital Signal Processing
EK 5917	Applications of Formal Methods
EK 5935	Advanced Discrete Mathematics
EK 6506	Statisticomechanical Concepts in Engineering
EK 6560	Introduction to Robotics

### **ELECTIVES**

Students can select electives from the different specialization areas if they do not wish to fulfill a specific specialization.

## **THE AUA GRADUATE PROGRAM IN CIVIL ENGINEERING**

Many aspects of our surroundings have been planned and designed by civil engineers. As a civil engineer, you may be involved in the planning of such diverse projects as residential and commercial buildings, urban development projects, dams, harbors, offshore facilities or transportation systems.

AUA has offered Civil Engineering for more than 25 years and since 2000, AUA graduates have been following the procedure to become graduate and later chartered engineers at the Institute of Civil Engineers.

### **AREAS OF SPECIALIZATION**

#### **ENGINEERING MECHANICS AND MATERIALS**

Courses in this specialization teach you to develop and apply means of describing and predicting the mechanical behavior of material (crystalline and/or brittle materials, polycrystalline metals, insulators, amorphous materials, composites and structures, individual elements or bridges or other structures) in their interaction with physical elements.

Some of the areas of study are:

- Mechanics of Continua with emphasis on Solids
- Science of Material and Materials Behavior (focus on concrete cement composites, steel, aluminum)
- Applied Mathematical Analysis, Theoretical and Applied Fracture Mechanics
- Numerical and Finite Element Analysis

#### **ENVIRONMENTAL ENGINEERING**

The program is designed to provide students with the fundamental knowledge of the various specializations of environmental engineering, paying extra focus on nanotechnology. These include among others, water, saline water, underwater, industrial wastes and pertinent regulatory requirements. The students are given a broad overview of each area which enables them to select specific areas for advanced study, if they should choose to do so. In this program the students have to take a number of required courses, along the following subject areas:

- Environmental and Physical Chemistry
- Water, Saline Water and Underwater Treatment Process
- Industrial Waste Treatment
- Hazardous Waste Management
- Advanced Treatment Process – using Nanotechnology

#### **GEOTECHNICAL ENGINEERING**

The main goal in this area of specialization is to provide essential tools for civil engineers who want to specialize in rock mechanics, foundation engineering and soil mechanics. A variety of theoretical and practical aspects of Geotechnical Engineering are available. Students are trained to undertake the analysis and design of such

geotechnical structures as embankments, underground structures, earth dams and tunnels.

The program also provides the knowledge necessary to design geo-environmental structures such as landfills and general infrastructure systems constructed on or in geomaterials. Some of the main topics in this area are:

- Rock Mechanics
- Soil Mechanics
- Foundation Engineering
- Geotechnical Earthquake Engineering
- Finite Element Analysis on Rock and Soil Mechanics
- Physiochemical Aspects of Soil and Rock Behavior
- Environmental Geotechnology
- Soil and or Rock Dynamics
- Tunneling
- Underground Water Management

## **STRUCTURAL ENGINEERING**

This area enables you to specialize in computer-aided structural design or structural dynamics of earthquake engineering. You develop specialized methods to analyze various types of dynamic excitation on the infra and superstructures of complex building and bridge systems.

You will focus on topics such as:

- Reinforced Concrete and Pre-stressed Concrete Design
- Metal Structure Design with Emphasis on Steel Structures
- Soil Mechanics and Geotechnical Engineering
- Advanced Mechanics and Materials Science
- Composite Materials
- Analysis of Plates and Shells

## **TRANSPORTATION ENGINEERING**

This program offers a focused and comprehensive study of Transportation Systems Engineering and issues dealing with highways, airports and subway systems.