Computational simulation is becoming a primary means of analysis and decision making in national laboratories and aerospace, civil, mechanical and biomedical industries. From assessing the aerodynamic efficiency of wind turbine blades to evaluating the surgical design for a bypass graft, complex engineering systems can only be developed through advanced, nonlinear, multi-physics analyses (for example, computational fluid-structure interaction).

The skill set required to master advanced simulation is inherently interdisciplinary, requiring in-depth knowledge of advanced mathematics, numerical methods, and their computational implementation, as well as mechanical and engineering sciences.

Until now, there has been no master degree program for professional engineers in the nation focused on this emerging field. The Master of Advanced Study in Simulation-Based Engineering at UC San Diego offers a new interdisciplinary education paradigm, designed to provide high-level training for professional engineers who plan to become technical leaders in their corporations or laboratories.

Vision

Apply Finite Element commercial, in-house, or research software in a hands-on design project. Become a leader in engineering design, and lead your company’s response to future technical challenges. Earn a master’s degree in two years. Courses will be simultaneously offered on campus and online, on a schedule convenient for working engineers.

LEARN HOW TO SOLVE MULTI-PHYSICS ENGINEERING PROBLEMS USING THE TECHNIQUES OF MODERN COMPUTATIONAL ANALYSIS.

Program taught by UC San Diego faculty, who are leading experts in finite element methods, high performance computing, and material mechanics.
Simulation-Based Engineering  
Master of Advanced Study Degree

About the Master of Advanced Study
The Master of Advanced Study (MAS) is a unique multidisciplinary degree program focused on emerging technology areas that will be crucial for the future of engineering advancements. Courses will be taught by faculty in the departments of Structural Engineering and Mechanical and Aerospace Engineering at the UC San Diego Jacobs School of Engineering.

This high quality degree program is offered to working engineering professionals. Courses will be simultaneously offered on campus and online, on a schedule convenient for working engineers.

Who Should Apply
The Master of Advanced Study (MAS) program in Simulation-Based Engineering is designed for engineering professionals working in Aerospace, Civil, Defense, Mechanical and Biomedical Engineering industries. The program is geared towards engineers whose success on the job depends on their ability to perform high-fidelity engineering simulations. These professionals are often on a technical leadership track within their companies, in the area of engineering design and engineering management.

How to Apply
Visit http://maseng.ucsd.edu/sbe for complete application procedures.

Faculty Directors
Yuri Bazilevs  
Assistant Professor  
Structural Engineering

David Benson  
Professor  
Structural Engineering

Marc Meyers  
Professor, Mechanical and Aerospace Engineering and NanoEngineering

Coursework
The MAS in Simulation-Based Engineering is a 36-unit degree to be taken over two years in consecutive fall, winter and spring quarters (1-2 courses per quarter). The curriculum consists of eight required courses and one capstone project course. (Curriculum subject to minor changes.)

Fall Quarter-Year One
Computational Techniques in Finite Elements
Practical application of the finite element method to problems in solid mechanics including basic preprocessing and postprocessing. Topics include element types, mesh refinement, boundary conditions, dynamics, eigenvalue problems, and linear and nonlinear solution methods.

Finite Element Methods in Solid Mechanics I
Finite element methods for linear problems in solid mechanics. Emphasis on the principle of virtual work, finite element stiffness matrices, various finite element formulations and their accuracy, and the numerical implementation required to solve problems in small strain, isotropic elasticity in solid mechanics.

Finite Element Methods in Solid Mechanics II
Finite element methods for linear problems in structural dynamics. Beam, plate, and doubly curved shell elements are derived. Strategies for eliminating shear locking problems are introduced. Formulation and numerical solution of the equations of motion for structural dynamics are introduced and the effect of different mass matrix formations on the solution accuracy are explored.

Finite Element Methods for Fluids and Fluid-Structure Interaction
In the first part, development and application of advanced computational techniques for fluid flow, and stabilized and variational multiscale methods for finite element and related discretizations are stressed. Incompressible and compressible Navier-Stokes equations, and turbulence modeling will also be covered. In the second part, conservation laws on general moving domains, Arbitrary Lagrange-Eulerian (ALE) and spacetime approaches to fluid-structure interaction are covered. Suitable discretizations, mesh motion, and discrete solution strategies are discussed.

Winter Quarter-Year Two
Finite Element Methods in Solid Mechanics III
Finite element methods for problems with both material and geometrical (large deformations) nonlinearities. Total Lagrangian formulations. Basic solution methods for nonlinear equations applied to problems in plasticity and hyperelasticity.

Validation and Verification of Computational Models
Methods applied to the verification and validation of predictive numerical simulations with an emphasis on testing and finite element analysis for Structural Dynamics. Areas covered include code verification, solution verification, feature extraction, test-analysis correlations, statistical modeling, meta-modeling, calibration, and assessment of prediction accuracy. The quantification of uncertainty, both in the forward mode and inverse mode is also addressed.

Dynamic Behavior of Materials

Spring Quarter-Year Two
Topics in the mechanics of blood flow including analytical solutions for flow in deformable vessels, one-dimensional equations, cardiovascular anatomy, lumped parameter models, vascular trees, scaling laws, and an introduction to the biomechanics and treatment of adult and congenital cardiovascular diseases.

Finite Element Methods for Solid Mechanics IV
Finite element methods for problems with both material and geometrical (large deformations) nonlinearities. Total Lagrangian formulations. Basic solution methods for nonlinear equations applied to problems in plasticity and hyperelasticity.

Fall Quarter-Year Two
Applications of Simulation-Based Engineering
Students work individually or in small groups and use FEM software to produce a case study that involves nonlinear finite element analysis of an engineering system. Project may be directly tied to a particular problem at the student’s company.

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