INTERDISCIPLINARY DOCTOR OF PHILOSOPHY GRADUATE PROGRAM
COLLEGE OF ENGINEERING

SENSING, IDENTIFICATION, DIAGNOSTICS, AND REHABILITATION OF STRUCTURAL SYSTEMS (2004 – 2005)

DESCRIPTION

Two of the most pressing needs of existing structural systems are sustainability and diagnostics. Maintenance and rehabilitation planning is necessary to sustain structures (such as civil infrastructure, airplanes, automobiles) for longer time periods through natural aging and long-term deterioration processes. Structures subjected to extreme events such as impact loads, earthquakes, flood, hurricane, explosion, or turbulence need to be resistant or responsive to new or progressive damage. The interdisciplinary doctor of philosophy program in Sensing, Identification, Diagnostics, and Rehabilitation (SIDR) of Structural Systems provide students a unique research program that melds the state of the art in hardware and software to implement reliable diagnostics and to respond via innovative rehabilitation systems. Structural systems are defined here in the broadest sense can include buildings, bridges, highways, civil infrastructures (pipelines, tunnels, dams), aircraft, automobiles, machinery, nanostructures, materials, and thin walled structures. Students who graduate from the SIDR program will be uniquely prepared for careers in research in academe or industry, technology development, as consultants and service providers, and the design and renewal of structural systems.

ADMISSIONS PROCEDURES

Applicants should apply to the engineering program (Civil, Mechanical, Electrical, Computer, Industrial, Chemical) most closely related to existing background and education, denote interdisciplinary SIDR PhD in the application materials, and include a personal statement that describes interdisciplinary research interests in the area of sensing, identification, diagnostics, and rehabilitation. Prospective applicants are encouraged to contact lead faculty regarding research opportunities and admissions. Applications will be reviewed in January and February of each year. Students who demonstrate outstanding academic abilities, the ability to perform original and independent research, and the potential to flourish in an interdisciplinary environment will be admitted into the program. The course work and advising structure is designed to integrate disciplines and the program does not favor one application background over another.

FACULTY

Lead and participating faculty come from a diverse background creating a combined expertise in sensing, diagnostics, and rehabilitation. Each faculty member resides in one of four home departments: Chemical Engineering (CHE); Civil and Environmental Engineering (CEE); Electrical and Computer Engineering (ECE); and Mechanical Industrial and Manufacturing Engineering (MIME). Faculty with affiliation with the National Science Foundation funded Engineering Research Center for Subsurface Sensing and Imaging Systems (CenSSIS) are denoted by [C].

LEAD FACULTY (alphabetized):

George Adams (PhD. UC Berkeley). Professor of Mechanical Engineering. Contact Mechanics and Tribology; MicroElectroMechanical Systems (MEMS), especially RF MEMS Switches and MicroMirrors; Nano Mechanics; Dynamic Response of Structures to Moving Loads; Mechanics and Tribology of Information Storage and Processing Systems. (MIME)

Dionisio Bernal (PhD, University of Tennessee). Associate Professor of Civil Engineering. Structural Dynamics, and Earthquake Engineering, Structural Stability, Health Monitoring and System Identification. (CEE).

Carey Rappaport [C] (PhD, Massachusetts Institute of Technology). Professor of Electrical Engineering and Associate Director of the Center for Subsurface Sensing and Imaging Systems. Electromagnetic systems, radar, subsurface imaging, signal processing (ECE)

Mehrdad Sasani (PhD, UC Berkeley). Assistant Professor Civil Engineering. Performance-based design, reliability, earthquake engineering (CEE)

Bahram Shafai [C] (PhD, George Washington University) Professor of Electrical Engineering. Control systems and signal processing, fault detection and identification, estimation, robust and adaptive control (ECE)

Sara Wadia-Fascetti [C] (PhD, Stanford University) Associate Professor of Civil Engineering. Structural diagnostics, fuzzy mathematics, infrastructure degradation and assessment, model updating, and subsurface imaging applied to civil infrastructure (CEE)

PARTICIPATING FACULTY (alphabetized):

Akram Alshawabkeh [C] (Louisiana State University) Associate Professor of Civil Engineering: Subsurface Sensing, Soil Remediation, Contaminant Fate and Transport, Geochemistry, Electrochemical Soil Processing, Soil Stabilization. (CEE)

Stefano Basagni (University of Texas at Dallas and Universita degli Studi di Milano, Italy) Assistant Professor of Computer Engineering. Network Protocols, Bluetooth Scatternet Formation; GPS-Enabled Communications; Wireless Network Security; Distributed Algorithms, Wireless Networks. (ECE)

Ahmed Busnaina (Oklahoma State University) William Lincoln Smith Professor. Semiconductor manufacturing processes such as CVD, PVD, electroplating, with an emphasis on nanofabrication. Wafer cleaning technology, chemical and particulate contamination in LPCVD and sputtering processes, fine particle adhesion, transport deposition and removal in clean environments. (MIME)

Dana Brooks [C] (Northeastern University) Associate Professor of Electrical Engineering. Digital Signal and Image Processing, Electrocardiography, Inverse Problem of Electrocardiography, Quantification of Multi-sensor Time-varying Electrical Patterns. (ECE)

Thomas Cullinane [C] (Virginia Polytech Institute) Professor of Industrial Engineering. Manufacturing Systems, Facilities Planning; Project Management; Graduate Education; Entrepreneurial Education. (MIME)

Peter Furth (Massachusetts Institute of Technology) Professor of Civil and Department Chair. Experimental Sampling, Uncertainty Modeling, Transportation Modeling, Sampling and Data Collection, Traffic Engineering, Transit Operations and Planning. (CEE)

Jackie Isaacs (Massachusetts Institute of Technology) Associate Professor of Mechanical Engineering. Economic Assessment of Manufacturing Processes; Automotive Recycling & Technology Assessment; Life Cycle Analysis and Industrial Ecology; Design for Disassembly. (MIME)

Haris Koutsopoulos (Massachusetts Institute of Technology) Associate Professor of Civil Engineering. Intelligent Transportation Systems, Transit Operations, Traffic Simulation Models, Dynamic Traffic Assignment. (CEE)

Nicol McGruer (Michigan State University) Professor of Electrical Engineering. Microrelays, MEMS-based emission spectroscopy chip, MEMS sensors for biomimetic robots, MEMS sensors for measurement of vibration, pressure and temperature. (ECE)

Eric Miller [C] (Massachusetts Institute of Technology) Associate Professor of Electrical Engineering. Signal and Image Processing; Inverse Problems, Medical Imaging. (ECE).

Hamid Nayeb-Hashemi (Massachusetts Institute of Technology) Professor of Mechanical Engineering. Nondestructive testing, finite element modeling, vibrations. (MIME)

Al Sacco (Massachusetts Institute of Technology) George A. Snell Professor of Engineering. Materials Technology, Sensors and Smart Materials. (CHE)

Philip Serafim (Massachusetts Institute of Technology) Professor of Electrical Engineering. Electromagnetics; Propagation through random media; Volume Scattering, Radar Clutter; Microwave Remote Sensing; Electronic Devices; Gyrotron; Free Electron Lasers; Plasma; Nonlinear Interactions. (ECE)

Thomas Sheahan (Massachusetts Institute of Technology) Associate Professor of Civil Engineering. Rate Effects in Cohesive Soils, Soil Nailing, Coastal Sediments. (CEE)

Allen Soyster (Carnegie Mellon) Dean and Professor of Industrial Engineering. Optimization, Graduate Education. (COE)

Gilead Tadmor (Weizmann Institute of Science) Professor of Electrical Engineering. Basic System Theory; Distributed Parameter Systems; Discrete Event Control Systems; Robust and Optimal Control; System Identification; Nonlinear Control; Estimation Problems. (ECE)

Ali Touran (Stanford University) Associate Professor of Civil Engineering. Construction Cost/Schedule Uncertainty, Simulation, Construction Productivity. (CEE)

Grant Warner (Columbia University) Assistant Professor of Mechanical Engineering. Dynamics and Control, Energy Harvesting (MIME)

Mishac Yegian (Massachusetts Institute of Technology) Professor of Civil Enginering. Earthquake Engineering, Soil Dynamics, Bridge Foundation Systems

Curricula Requirements for Graduation (Academic Year: 2004 – 2005)

Students must demonstrate outstanding academic abilities and have taken at least 52 SHof coursework. Up to 28 SH of coursework taken in an approved Masters of Science program can be applied to graduation requirements. Students will be required to pass three exams: qualifying, research proposal, and defense. The doctoral dissertation must be interdisciplinary spanning at least two fields while demonstrating a solid grounding in the candidates 'home' discpline.

We expect students who graduate with a Doctoral Degree in the Interdisciplinary Program of Sensing, Identification, Diagnostics, and Rehabilitation of Structural Systems are expected to acquire a fundamental background in the problem areas, sensing technologies, and signal processing and interpretation. Therefore, students must take at least two of the courses listed in each of the 'toolbox,' 'sensing,' 'identification/diagnostics,' and 'rehabilitation' categories. Accommodation can be made through petition to the PhD advisor and the SIDR Faculty Leadership Committee to accept additional courses as part of the SIDR curricula requirements.

Tool Box Courses are those courses that provide necessary fundamental theory and computational tools for advanced study in SIDR.

MTM G200 (G205) Mathematical Methods (Advanced)
ECE G204 Linear Systems Analysis
ECE G203 Complex Variable Thry & Differential Eqns
ECE G110 Digital Signal Processing
MTM G210 Elasticity and Placticity
ECE G335 Detection and Estimation
ECE G103 Classical Control Systems
ECE G202 Electromagnetic Theory
IEM G200, ECE G204 Probability Course
MTM G220 Advanced Mechanics of Materials

Framework for course selection: Students must take a suite of courses as preparation for interdisciplinary research within the fields of Sensing, Identification, Diagnostics and Rehabilitation.

Sensing includes all aspects of acquiring measurements from hardware (sensors and application for measurement) to communication and signal processing.

Identification is a data driven approach to develop an analytical system model.

Diagnostics is the analysis and decision making process to determine existence, location, and magnitude of damage or degradation as well as a determination of future consequences to the structure.

Rehabilitation is the action taken in response to diagnosis for repair or long-term improvement of the structural system.

Sensing	ID / Diagnostics	Rehabilitation
ECE G312 Statistical and Adaptive Signal Processing	CIV G331 Structural Dynamics	CIV G341 Structural Reliability
ECE G273 Remote Sensing	MTM G215 Dynamics and Mechanical Vibration	MTM G225 Control and Mechatronics
ECE G334 Wireless Communications	MTM G250 Advanced Topics in Vibrations	CIV 342 Structural Identification and Diagnostics
MTM G260 Introduction to Micro Electromechanical Systems - MEMS (also ECE G244)	ECE G213 System Identification and Adaptive Control	CIV G330 Structural Analysis
ECE G272 Radar Systems	ECE 1467 Introduction to Subsurface Sensing and Imaging	CIV 342 Seismic Design
ECE G286 IR Imaging	ECE G398 Introduction to Inverse Problems	MTM G235 Finite Element Analysis
ECE G275 Antennaes and Radiation	MTM G245 Fracture Mechanics and Failure Analysis	CIV G351 Behavior of Steel Structures
ECE G283 Optics for Engineers	CIV G303 Geotechnical Instrumentation	CIV G350 Behavior of Concrete Structures

SIDR Research Requirements:
The Doctor of Philosophy is a research degree and all students will be required to complete original and independent research documented in a dissertation. Students will be advised by two co-advisors from two different departments on a jointly defined research projects. As part of research training, students will have the opportunity to participate in a research rotation to be exposed to all aspects of SIDR. The formation of the qualifying exam committee and the dissertation committee will follow the College of Engineering Interdisciplinary Doctor of Philosophy guidelines, repeated here for completeness. The doctoral dissertation is expected to be a document that describes interdisciplinary contributions.

COLLEGE OF ENGINEERING GRADUATE SCHOOL REQUIREMENTS FOR THE INTERDISCIPLINARY DOCTOR OF PHILOSOPHY

The Graduate School of Engineering offers the opportunity for an interdisciplinary doctoral program involving substantial work in two or more departments. A written proposal describing the areas of proposed study and research should be submitted with the student's application. Interdisciplinary study requires favorable recommendation by the sponsoring doctoral degree-granting department and approval by authorized representatives of the graduate study committees of the departments appropriate to the disciplines covered by the student's proposal. The sponsoring department is the registration base of the student.

Formation of Interdisciplinary Committee

A student who has been accepted for interdisciplinary study must obtain the consent of an adviser who will direct his or her doctoral thesis. This adviser, who may or may not be a member of the registration department, will be chairman of the interdisciplinary committee for this student. A second member will be appointed from the registration department by its chairman. These two members will obtain one or more additional members or request the director of the graduate school to do so. At least two departments must be represented on the committee, and a majority of the committee must come from doctoral degree-granting departments. The chairman of the registration department will notify the Director of the Graduate School of the membership of the committee as soon as arrangements are complete.

Duties of Interdisciplinary Committee

A member of the interdisciplinary committee who is also a member of the registration department will serve as the registration officer to approve the course registration for the student. A copy of the approved course registration must also be filed with the other committee members and with the graduate study committee of the registration department.

The interdisciplinary committee will be responsible for the administration of the qualifying examination, language examination, approval of the dissertation, and comprehensive examination. This committee must also certify to the registration department the completion of the requirements for the award of the doctoral degree.

The interdisciplinary committee must assure that the program of the student represents standards comparable to those of the registration department and that the program is not so broad that it has inadequate depth in any area.

The student's program may be reviewed at any time by the Director of the Graduate School to determine whether objectives of the program are being met.