Florida A&M University-Florida State University
COLLEGE OF ENGINEERING
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Florida A&M University—Florida State University
College of Engineering
Capability Statement

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OVERVIEW

The **FAMU-FSU College of Engineering** is a unique institution established as a joint program serving two universities in Tallahassee, Florida: The Florida Agricultural and Mechanical University (FAMU) and The Florida State University (FSU). FAMU has received recognition from the National Academy of Sciences and the National Academy of Engineering in 2010 for ranking number one as the institution of origin for African Americans earning Doctorates in Natural Science and Engineering. Florida State University is a Carnegie R1 (Highest Research Activity) institution with extensive graduate and research programs.

The College is a leading academic institution with an excellent record of achievement in research and public service. It offers Bachelor of Science (B.S.), M.S. and Ph.D. programs in chemical & biomedical, civil & environmental, electrical & computer, industrial and manufacturing and mechanical engineering. The College has attracted an outstanding faculty from all over the world. The joint college combines and leverages the unique strengths of both institutions to deliver a world-class engineering education that is anchored by extensive student engagement in leading edge research and training. Thousands of young, intelligent and highly motivated students have graduated from the College in the last two decades, which has granted over 5000 degrees. Our student population is one of the most diverse groups in terms of race, ethnicity, gender and nationality out of all the U.S. colleges of engineering.

RESEARCH CAPABILITIES

The **FAMU-FSU College of Engineering** is comprised of five academic departments and a number of specialized research centers:

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The Department of Chemical and Biomedical Engineering (CBE) faculty specialize in research in aerosol science and engineering: biomaterials; drug targeting and delivery systems; materials for cell and tissue engineering; nanostructured materials; polymers; systems, computational and synthetic biology; air pollution; cellular and metabolic engineering; fossil energy extraction and processing; molecular transport process; plasma reaction engineering; renewable and advanced power production.

The Department of Civil and Environmental Engineering (CEE) has a distinguished record of research in environmental engineering; remediation of soil and groundwater; sustainable waste management; mitigation greenhouse emissions; hydraulic/water resources; stormwater management; surface water modeling; ground-water flow and contamination transport modeling; bioremediation kinetics; wind engineering; hurricane effects on structures; transportation design and materials; pavement design and management; transportation safety issues; intelligent transportation systems; traffic modeling and computer applications; traffic safety and crash reduction; geotechnical engineering; structural engineering and mechanics; construction engineering and management; advanced composite materials; bridge analysis and design; computer applications and GPS/GIS applications.

Center for Accessibility and Safety for an Aging Population (ASAP) is a multidisciplinary collaboration, led by researchers from the Department of Civil and Environmental Engineering, to conduct research in the primary area of transportation engineering, as well as to perform educational and outreach programs. Motivated by Florida's large number of senior residents, the reported relatively high involvement of seniors in traffic incidents and their special needs for transportation; the theme of ASAP is to provide safe and accessible transportation to the aging population. The center is supported by a strong research team from various disciplines including civil engineering, urban planning, geography, psychology, and health care management.

The Department of Electrical and Computer Engineering (ECE) is actively involved in research of advanced power systems, nano and power electronics, electric vehicles (EV), plug-in hybrid electric vehicles (PHEV), electric machinery and motor drives, energy storage and conversion, renewable energy, multi-junction III-V compound solar cells, polymer solar cells, robotics, computational intelligence, biomimetics digital signal processing, electromagnetic, photonics/optoelectronics, smart Antennas, RF/microwave circuits, superconductivity, wireless communications, computer networks, embedded systems, special purpose architectures, and intelligent transportation systems.

Center for Advanced Power Systems (CAPS) is a multidisciplinary research center associated with the Department of Electrical and Computer Engineering. CAPS members perform basic and applied research to advance the field of power systems technology with emphasis on application to electric utility, defense, and transportation. The Center has core competencies in the areas of power systems modeling, analysis, and control in the context of real-time digital simulators, power electronics, electrical machines and drive systems, superconductivity, and thermal systems analysis.

The Department of Industrial and Manufacturing Engineering (IME) researchers focus on the design, improvement and installation of integrated systems of people, material, information, equipment and energy. The department is committed to providing a solid industrial engineering curriculum coupled with a strong research

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program driven by the economic and technological development needs of society. The Department's graduate studies program is organized into two tracks: (1) Manufacturing Systems and Engineering, and (2) Quality Engineering and Industrial Systems. Additional emphasis is placed on a Specialization in Engineering Management MSIE and Orthotics/Prosthetics MSIE.

***The High-Performance Materials Institute (HPMI*)** is a multidisciplinary research institute associated with the IME Department. HPMI strives to recruit, develop and retain top quality faculty and staff who will develop HPMI into a center of excellence for research and education in the field of advanced materials. Currently, HPMI is involved in four primary technology areas: (1) High-Performance Composite and Nanomaterials, (2) Structural Health Monitoring, (2) Multifunctional Nanomaterials Advanced Manufacturing and (4) Process Modeling. The Institute employs approximately 60 graduate and 30 undergraduate students each semester.

The Mechanical Engineering Department (ME) is actively involved in basic and applied research designed to solve both present and future technological needs of society. The major research activities focus on four primary areas: dynamic systems and controls (including mechatronics and robotics), fluid mechanics and heat transfer, materials science, and sustainable energy systems. State-of-the-art research laboratories are associated with each of these areas at the following research centers:

Center for Intelligent, Systems, Control, and Robotics (CISCOR) is committed to using state-of-the-art technology to develop practical solutions to problems in systems, control, and robotics for applications in industry and government. CISCOR faculty come from Mechanical Engineering, Electrical and Computer Engineering, Computer Science, and Statistics and provide expertise such as mechanical design, dynamic modeling, control, artificial intelligence, pattern recognition, and computer vision.

Energy and Sustainability Center (ESC) addresses the most challenging energy issues related to the use of alternative energy through the development of innovative solutions for consumers and industry. Technologies and areas of expertise include: off-grid zero emission buildings, algae photo-bio-reactors, solar-thermal tri-generation systems, waste heat recovery, solar driven power cycles, fuel cells, and thermodynamic optimization of energy conversion systems

Florida Center for Advanced Aero-Propulsion (FCAAP) is a State of Florida University System Center of Excellence involving multiple universities in Florida and led by FAMU-FSU College of Engineering faculty. The principal focuses are aerospace, aviation and related areas, such as power generation and energy. FCAAP's research and technology contributions are recognized nationally and internationally. Some of FCAAP's state-of-the-art facilities include the: 1) Polysonic wind tunnel, 2) Subsonic wind tunnel, 3) Anechoic wind tunnel, 4) High temperature jet & anechoic facility, and 5) Short take-off and vertical landing (STOVL) facility.

Applied Superconductivity Center (ASC) advances the science and technology of superconducting magnets; working from atomic scale fundamentals through complex conductors to construction of the highest field superconducting magnets yet made. ASC has comprehensive laboratories for superconductor fabrication, superconducting property and microstructural evaluations, and magnet construction and testing.

National High Magnetic Field Laboratory (NHMFL) is a national, NSF funded research center which provides a forum for researchers from a variety of disciplines, including researchers from the FAMU-FSU College of Engineering. The mission of NHMFL, as set forth by NSF, is: "To provide the highest magnetic fields and necessary services for scientific research conducted by users from a wide range of disciplines, including physics, chemistry, materials science, engineering, biology and geology." In line with this mission, this laboratory generates the world's highest DC magnetic fields. College of Engineering researchers in the MagLab perform research and development projects involving very low temperature science and technology, relevant to the cooling of superconducting magnets.

FACILITIES, MAJOR AND SPECIALIZED INSTRUMENTATION:
The research centers and institutes noted above are equipped with a wide range of state-of-the art test facilities, diagnostics and measurement capabilities, and other research infrastructure to support the leading edge research of faculty and scientists at these centers. A brief summary of some notable capabilities are given below.

CENTER FOR ADVANCED POWER SYSTEMS (CAPS)

Real Time Digital Simulator (RTDS). The RTDS is a special purpose multi-processor computer system that is optimized for power system simulations. It is designed for real-time simulation, which means that the computation of the simulated system advances one moment in each moment of wall-clock time. In a low risk, yet realistic environment, the simulator can test a critical electrical grid without actually turning off the lights around the nation or putting a ship in harm’s way.

5 MW Prototype Test Facility. CAPS offers a state-of –the-art test facility for evaluating prototype electric machines and devices. The facility couples real hardware with the largest Real Time Digital Simulator (RTDS) in any university and is one of the largest capabilities for real-time digital power system simulation and modeling available anywhere in the world. This test facility includes a 5MW dynamometer and a 5MW variable voltage converter designed for high-power wave form generation. These devices, in tandem with the RTDS, allow CAPS users to test their machinery in any environment that can be simulated. In 2011, a 5MW two-stage gearbox was added to this test facility to facilitate the testing of electric machines up to 24,000 RPM. This marriage of hardware and simulation provides a unique, Hardware-in-the-Loop (HIL) test capability unmatched by other research facilities.

AC Variable Voltage Frequency Converter. The advanced power systems test bed consists of a highly flexible, re-configurable 4.16kV distribution system with a stiff connection through a dedicated 7.5 MVA service transformer to an adjacent utility substation 115:12.5kV distribution transformer. This provides, for the first time, the ability to conduct power hardware-in-the-loop (PHIL) experiments, with electrical equipment interacted with high-fidelity simulation, at power levels up to 5 MW. This concept fully integrates the device under test, which is connected to the VVS bus, into a simulated system environment at an unprecedented high level of fidelity.

5 MW Dynamometer and Gear Box. The dynamometer and gear box system together gives us flexibility to test a wide range of rotating machines in the 5 MW power rating and speed ratings up to 24,000 RPM. One of the recent projects was to test a MW range novel design 1,000 RPM permanent magnet machine. The test plan required testing the machine in both operating modes, first as a generator then as a motor. The machine was coupled to the dynamometer and powered by the variable voltage source converter controlled by the RTDS. This was the first MW scale experiment, which required the dynamometer, power converter and device under the test to work together under the control of the RTDS. Other novel machines tested were a 5 MW 230 RPM HTS propulsion motor and a 15000 RPM 1.5 MW compact high speed generator.

EMS/SCADA (energy management system/supervisory control and data acquisition). Process Information and Protection Facility is integrated with the realistic power systems, research and test environment provided by the FSU-CAPS real-time simulation, and hardware-in-the-loop capabilities, including commercial real-time control, information and protection systems. This facilitates research and education activities involving collection and analysis of large amounts of measured data, investigations into power system protection and control schemes (including wide area protection or use of synchrophasor measurements in control) and investigation into the human interface and visualization aspects of grid operation and control. Industry partners providing software licensing and equipment to outfit our facility for these purposes include OSISoft, Areva (now Alstom Grid), Schweitzer Engineering Laboratories (SEL) and Beckwith Electric.

5 MW MVDC Power Amplifier. In 2013 CAPS test facility received another valuable addition to our infrastructure; a 5MW 24,000 V DC medium-voltage power amplifier, manufactured by ABB based on our specifications. The installation consists of four power converters each rated at 6,000 kV DC and 210 A. Parallel and series configuration of the converters makes it possible to test complex DC distribution systems at 6, 12 or 24 kV in the MW range, depending on the system requirements. The system can work in floating mode or with the positive or negative bus grounded. Also, midpoints of two converter configurations can be grounded to create a bipolar operation (i.e. +/- 12 kV DC). The converters are built using Modular Multilevel Converter (MMC) technology and were manufactured for FSU by ABB as a technology demonstrator and to be used for future electric power distribution research and development.

FLORIDA CENTER FOR ADVANCED AERO-PROPULSION (FCAAP)

Polysonic Wind Tunnel has a 12" x 12" test section and a Mach number range of 0.2 to 5.0. This includes the transonic regime. Run times vary between 60 and 100 seconds depending on flow conditions. The facility is equipped with a model support system with continuous pitch control from - 10° to 15° and continuous roll control from -180° to 180°.The facility includes a settling chamber with an acoustic silencer, 5 flow conditioning screens, and a honeycomb to minimize test section noise and turbulence levels. Supersonic Mach number is controlled using fix nozzle blocks. Currently the facility has a subsonic nozzle and individual nozzles for blocking Mach 2.0, 3.0, 4.0, and 5.0. There are two test sections: sub/supersonic flow (24" long) and a slotted wall transonic test section (48" long). Both test sections have large optical access for a wide range of non-intrusive measurement techniques along with more conventional measurement techniques.

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Subsonic Wind Tunnel Facility allows for high-fidelity aerodynamic testing. The facility is a single pass, Eiffel styled, wind tunnel which is driven by a 200 hp suck-down fan, which minimizes noise through the test section. The facility incorporates a 30" wide x 30" high x 60" long test section and allows for testing at a range of speeds from 2 - 80 m/s (5 - 180 mph). The upstream flow conditioning devices allow for tests to be run with minimal flow angularity and turbulence intensities less than 0.5%. The test section is easily reconfigurable, allowing it to be used for a wide variety of test requirements. The wind tunnel is equipped with a 3-axis motorized traverse for acquiring traditional 'probe-type' measurements including hot wire anemometry and pressure probes as well as for translating optical diagnostic hardware.

Supersonic Pilot Wind Tunnel is an intermittent blow down type facility. Tests can be carried out over a range of subsonic and supersonic Mach numbers with the current design's ease of nozzle replacement. The present test section is 101 mm wide, 76 mm high, and 381 mm long, with the side walls and floor made from optical quality glass for flow visualization and optical diagnostics such as particle image velocimetry (PIV).

Supersonic Hot Jet Facility is a research facility capable of producing high-temperature, high-speed airflow essential to accurately simulate the exhaust from a jet engine. This blow-down type facility is supplied by six compressed air storage tanks and employs a sudden expansion ethylene burner to generate jets of air at temperatures of up to 2200°F and ideally expanded jets at speeds beyond Mach 2.5. Single and multiple nozzles of various geometry can be easily implemented and the integration of supplementary airflow subsystems permit investigations of various co/counter-flow configurations. The jet exhausts into a fully anechoic chamber providing the means to accurately perform a multitude of aeroacoustic studies.

Short Take-Off and Vertical Landing (STOVL) Jet Facility provides a means to study both free jet and impinging jet flow physics through the use of several optical diagnostic techniques including Schlieren photography, Particle Image Velocimetry, Background Oriented Schlieren and Pressure Sensitive Paints. Various configurations can be tested with a Mach number range of 0.5-2.2 with geometries including conical, elliptical, rectangular, and chevron nozzles. In addition, with the use of a 192 kW inline electric heater, the stagnation temperature can be raised to nearly 1000°F to study the effects of temperature. With the addition of a secondary, independently controlled pressure supply line, the facility's capabilities expand to include twin nozzle configurations, co-flow and the interaction of cold and hot streams. The primary focus of the facility is to improve current knowledge in an effort to effectively and intelligently design and test control devices aimed at reducing high noise levels associated by free and impinging high speed jets.

Anechoic Jet Facility is an open-circuit subsonic facility which has a 36" x 48" x 120" test section with a speed range of approximately 18-75 m/s. The facility employs a 450-hp centrifugal fan and has an anechoic chamber with a 250 Hz cut-on frequency enclosing the test section. The open-jet can be converted into a closed-wall wind tunnel as it has a removable test section with excellent optical access. The facility is used for aerodynamic and aeroacoustic studies of various flow-induced noise phenomenon and boasts state-of-the-art experimental fluid dynamic and aeroacoustic measurement capabilities.

Micro-Actuator Laboratory. Micro-actuators developed for active control of high-speed flows are characterized in the Micro-Actuator Development Laboratory. Due to the scale of these actuators and the unsteady nature of the high-speed flows produced by them, specialized techniques are required for their characterization. Experiments conducted in this laboratory typically include measuring acoustic data, unsteady pressure fluctuations, and velocity field measurements using Particle Image Velocimetry (PIV). High magnification flowfield images of the actuators are also acquired using highly sensitive Schlieren systems, such as the Laser-Based Micro-Schlieren system. The detailed analyses performed in this laboratory have led to the successful implementation and demonstration of the capabilities of these actuators in high-speed flow facilities, such as the STOVL impinging jet facility and the supersonic wind tunnel.

All of the above FCAAP Wind Tunnels and Jet Facilities are equipped with the most advanced, state of the art flow diagnostics such as Planar, Stereo, Tomo and High Speed Particle Image Velocimetry (PIV), Ultra-high speed cameras for real time flow visualization, image acquisition, advanced data acquisition, processing and control hardware. Some notable hardware includes:

- LabVIEW based facility operation and data acquisition programs
- Signal conditioning systems including amplifiers & filters
- High speed simultaneously sampling data acquisition hardware
- Planar (2D), Stereoscopic (3D), and Tomographic (3D) Particle Image Velocimetry (PIV)
- Flow visualization using shadowgraph and Schlieren techniques
- High resolution Background Oriented Schlieren
- Pulsed ND-YAG laser and High resolution CCD cameras
- High-speed Pulsed ND-YAG lasers (10kHz)
- High-speed cameras with frame rates up to 600,000 fps
- FLIR Short-Wave Infrared Video Camera
- Skin friction and surface-oil flow visualization
- Smoke visualization
- Linear and Circular Microphone arrays (Bruel & Kjaer Microphones)
- Hotwire Anemometry, Pitot-Static, and multi-hole probes
- High frequency unsteady pressure sensors
- High Temperature Unsteady Pressure Probes
- Computer controlled multi-axis traverse systems
- Force measurements using 6-component strain gauge balances

HIGH-PERFORMANCE MATERIALS INSTITUTE (HPMI)

The High-Performance Materials Institute (HPMI) has a comprehensive set of state-of-the-art materials processing, testing, characterization and computing facilities for materials and nanomaterials research housed in the 47,000 square foot Materials Research Building.

Advanced Imaging, Microscopy and Spectroscopy capabilities are achieved using HPMI's Atomic Force Microscope, Scanning Electron Microscope, and a Transmission electron microscope with cryogenic capability, a Renishaw Confocal Research Raman Microscopy (upgraded InVia, 633 nm and 785 nm laser sources), and a Bruker Nanostar SAXS/WAXS X-ray scattering machine.

Rheological Characterization, Thermal-physical and Electrical analysis are conducted using a Rheometer, two Electrical Conductivity Measurement Systems with cryogenic capability, a Thermal Conductivity Measurement System, a Differential Scanning Calorimeter, a Thermomechanical Analyzer, a Thermogravimetric Analyzer, and two Dynamic Mechanical Analyzers.

Conventional composite to nanomaterial research is carried out using HPMI's ASC, Econoclave EC3X6 autoclave or ovens and hot press machines of various sizes. HPMI also has various methods for producing nanotube membranes or buckypaper, production of nanotube composites, modeling techniques of nanotube-epoxy interaction at the molecular level, and equipment for a variety characterization tests, such as equipment for electrical resistivity testing. Nanomaterial research also uses HPMI's EasyTube 3000 Chemical Vapor Deposition System, and various high-temperature vacuum tube furnaces.

For mechanical property testing, HPMI has multiple machines, including a Shimadzu AGS-J micro test frame (500 N and 1 kN load cells), a MTS 858 table top test machine (25KN, hydraulic grips, laser strain gauge), and a MTS Landmark Servo-hydraulic System.

Advanced manufacturing involves HPMI's multiple aerogel, FDM and inkjet 3D printing machines, and a new state-of-the-art high precision and multiple material printer.

The OMAX 55100/30 Waterjet cutter is used by HPMI for preparing samples, by the National High Magnetic Field Laboratory for cutting copper for use in magnets, and by FSU's Master Craftsman program for various artwork around Tallahassee.

Advanced engineering design, modeling and simulation software available includes Matlab, COMSOL Multiphysics, SolidWorks, AutoCAD, ProEngineer.

PAST PERFORMANCE

The researchers from the FAMU-FSU College of Engineering have been, on average, generating over $25 million annually in research expenditures from external sponsors (based on the expenditures for fiscal years 2012-2016). Funding in the research areas identified above has been provided by all major federal sponsors, such as the National Science Foundation, the National Institutes of Health, the U.S. Department of Defense, the U.S. Department of Energy and NASA. Also, a significant portion of the sponsored research projects performed by the College's researchers have been financed by the leading private companies including, among others, Boeing, Lockheed Martin, Northrop Grumman, and Honda.