Florida International University
College of Engineering and Computing
10555 W Flagler St, Miami, FL 33174 Phone
(305) 348-2522

College of Engineering and Computing
Capability Statement

DUNS No: **07-129-8814**
Cage Code: **1JHM5**
NACIS ID(s): **611310**
Federal ID No: **65-0177616**
CEC Number: **07-220-891B**
Certificates, Registrations, Accreditations: **Southern Association of Colleges and Schools Commission on Colleges (SACSCOC), Accreditation Board for Engineering and Technology (ABET), Commission on Accreditation of Allied Health Education Programs (CAAHEP), American Council for Construction Education (ACCE).**

POC Information: **Dr. Osama A. Mohammed, Associate Dean for Research**
Address: 10555 West Flagler Street, EC-2441, Miami, FL 33174 Tel: (305) 348-3040, Email: mohammed@fiu.edu https://cec.fiu.edu/

Overview:

The **FIU College of Engineering and Computing** is South Florida's leading engineering education resource. The college offers a complete range of fully accredited engineering bachelor's, master's, and doctoral degree programs in biomedical, civil, and environmental, electrical and computer, and mechanical and materials engineering; construction management; and computing and information sciences. With close to $25M of external funding, research is an integral part of the college's mission and its success.

FIU's College of Engineering & Computing is committed to providing quality education, problem solving research, and community engagement through local relevance, national visibility, and global exposure. As an educational leader in a changing economic, technological, and social environment, and as the research engine of the university, the college is proud of its growth and accomplishments in recent years. Furthermore, our ASEE and NSF HERD rankings have seen significant improvements. We rank #1 in the continental U.S. in awarding bachelor's degrees to Hispanic students, #11 in awarding bachelor's degrees to African Americans and among top 40 in the nation in awarding for the number of bachelor's degrees awarded to women.

Research Capabilities:

Cybersecurity: Wireless Network Encryption, Cloud Computing, Security of Critical Infrastructure Networks, Security of Wearables, Internet of Things, Mobile Malware, Mobile Authentication, Social Media Validation, Fraud and Malware Detection in Social Networks, Cryptocurrencies, Smart Home Security.

Robotics, Automation and Manufacturing: Robotic inspection, sampling and surveying, Robotics technology for waste site operations, Mechatronic design of robotic and automation systems, Biomedical use of robotics, Development of modular architectures, 3D printing, packaging, High-precision quality fabrication, Bulk metallic glass manufacturing and characterization.

Materials and Nanofabrication: Bio and Chemical Sensors, Computational Analysis, Computational Fluid Dynamics, Device and Sensor Fabrication, Electronic Materials and Ceramics, Failure Analysis Research, Materials Characterization and Process Development, Nanostructured Materials, Nanostructure Synthesis, Novel Materials for Reconfigurable Materials Plasmonics, Thermal, Fluid, Energy Studies.

Energy, Power and Sustainability: Make Solar Energy Economical, Access to Clean Water, Design and Develop Clean, Efficient, Reliable, Sustainable and Safe Energy Solutions, Energy Storage, Solid and Hazardous Waste Management, Environmental and Water Resources Management, Green and Sustainable Engineering Solutions.

Artificial Intelligence and Big Data: New Machine Learning and Language Processing, Design of Intelligent Virtual Agents, Social Media Analytics, Volume/Velocity/Variety Studies, Machine Learning Algorithms, System and Cloud Analytics, Business Intelligence and Analytics.

Telecommunications and the Wireless Revolution: 5G and Beyond, Antenna Design, Augmented Connectivity, Computational Electromagnetics, Internet of Things, Millimeter Waves and TeraHertz, Novel Materials for Sensing and Communication, Reconfigurable Devices and Systems, RF and Wireless Communications, RFID Tags, RF Materials and Packaging, Secure Cyberspace, Secure and High Data Rate Communications, Sensors and Sensing for Medical Applications, Tetherless Communications, Wearable and Textile Antennas.

Resilience and Infrastructure: Structural & Wind Engineering Against Extreme Events, Structural and Corrosion Engineering, Concrete Technology, Construction Technology, Simulation & Modeling, Safety Vibration, Impact, Reliability, Load Distribution, and Fatigue Damage Analyses.

Research Facilities:

We offer state-of-the-art shared research facilities and recharge centers that provide access to high end instruments, cutting edge technologies, and services. Our facilities enhance and expand the collaborative capabilities of our research community.

FIU Smart Grid Testbed: The FIU Smart Grid testbed includes a uniquely flexible and adaptable distribution system facility, for emulating a real-time AC distribution system capable of providing scenarios with online reconfigurable switches as well as multiple connected microgrids. This hardware-based laboratory implements a testbed power system smart grid and is composed of all needed hardware layers, Power, Communication, and Cyber Security. All layers are implementing the idea of a futuristic smart grid system. The testbed implements many of the industrial and commercial communication and control issues and can be operated physically on location, remotely and/or from a cloud interface. This FIU Smart Grid facility consists of three individual sections: 1) Smart renewable energy generation and integration, 2) Smart automation, control, and protection, and 3) Intelligent PV and Solar Integration with the legacy systems and new installations.

The Smart Grid Testbed was developed and implemented as an integrated hardware-based AC/DC Hybrid distribution system. This system is capable of producing power in AC form and DC form as well as storage with a total capacity of 120kW.

The AC part of the hardware setup involves 4 AC synchronous generating stations. Each generating station has 5 different types of motor drives acting as 5 different prime movers with different ratings to enable the implementation of various generation control strategies and operation scenarios. All generators are synchronized automatically and equipped with AVR. The various prime movers can also be utilized as wind energy emulators.

There are more than 15 various scales of feeder lines (pi-model) and cable hardware modules capable of carrying up to 25 amps per phase. There are 14 bus models to perform switching actions and collect measurements.

There are several measurements and Ethernet-based data acquisition units (DAQs) are capturing the real-time data in 12 kHz of sampling rate for more than 300 points in more than 27 feeders for individual voltages and currents. We have a wide variety of National Instrument (NI) DAQS to be suitable for different applications. Recently the system was extended by adding a 4 slot USB chassis and three modules.

There are three DC microgrids interfaced to the AC systems through bi-directional voltage source inverters. The first microgrid involves a Wind energy conversion system (WECS) emulator. Several Programmable DC power supplies are used to emulate the exact characteristics of solar and fuel cells, individually and combined. The second microgrid consists of supercapacitors, a Lithium battery system, and PV emulators to supply power for ramp rate loads. The third microgrid includes EV emulators with a central aggregator for EV parking operation. The networked microgrids is operated under advanced distributed or data-driven based controllers. Cloud computing, edge computing, and Digital Twin technologies are also applied with real-time measurements and a large amount of data.

The testbed also uses commercial equipment used in industry. This includes SEL industrial-level PMU and PDC devices as well as a synchronized vector processor to measure the power system parameters synchronized with a GPS clock whose antenna is installed on the building roof. ABB and SEL relaying systems with modern industry protocols (OPCUA, DNP3, IEC61850, etc.).

There are different types of protection relays to achieve the complete protection of the testbed such as motor protection relays, line protection relays, generator protection relays, etc. In addition, there are a substation automation and control devices COM600 and COM600R.COM600 provides gateway functions for mapping signals between protection and control IEDs in industrial or utility substations and higher-level systems. It further includes an optional HMI that provides data and information from the substation to the users. This also can be used for efficient substation visualization, monitoring, and control.

The communication layer at the FIU testbed is based on the Data Distribution Service (DDS) middleware. The Data Distribution service is a standard for data-centric communication middleware from the object management group (OMG). The DDS is data-centric middleware which helps to maintain the focus on the algorithm and control development rather than concerned with the communication and data delivery issues. The utilization of RTPS as a wire transfer protocol ensures interoperability between different vendors. For flexible integration with different application DDS provides standard application programming interface API for supporting Python, C, C++, Java and .NET. The DDS also supports Java message service (JMS) middleware allowing sending messages between clients.

The cyber-physical system is realized by Cyber Hardware-in-the-Loop setup with Realtime simulator OPAL-RT 4610, the controllers or the multi-agent system run in embedded devices FPGA, Raspberry PI, Arduino, STM, etc. and the physical communication network or emulated network in Ns3, GNS3. Various cyber-attack scenarios and solutions of attack mitigation in protection and control system are demonstrated. The developed SCADA system via Labview and COM600 HMI is used to monitor and remotely control whole system in the testbed.

Cyber-Physical Systems Security Lab (CSL): In CSL, the primary focus is work on research problems at the intersection of the cybersecurity and networking fields with an emphasis on their practical and applied aspects. We design, build, and analyze novel real-world systems, algorithms, and tools. The ultimate goal of our efforts in the CSL is to make today's and tomorrow's digital infrastructure and our lives more secure against malicious activities.

Moreover, the software capabilities for the include: proficiency with several simulation tools (ns3, ns-2, custom event-driven simulators such as GTNetS, OPNET), proficiency with Python, Python's packet capturing libraries (e.g., Scapy), parser generators (e.g., Pyparsing), Weka and Matlab for data analysis (including various toolboxes: statistics, signal processing), experience writing custom parsers (in C and Python) to parse binary pcap files as well as binary files generated from Ubertooth packet sniffer that were created during various experiments, and experience with embedded system programming using sensors.

FIU RFCOM Facilities and Equipment: The RFCOM Lab at Florida International University is devoted to world-class electromagnetic research in scattering, antennas, propagation, RF system, sensors, and sensing, wireless, signal processing, sensor fusion, THz, and photonics research. FIU RFCOM Lab is comprised of 12 faculty members. Our faculty, research scientists, and students are involved in all aspects of electromagnetic and RF technologies, including: Antennas, Bionanotechnology and nano-imprinting, Bio-Optics, Computational methods and design,

Electromagnetic compatibility and interference, Radars, Measurements Techniques, Device modeling, Multi-physics engineering, Packaging and interconnect design, Photonics, Propagation, Radar imaging, Remote sensing, RF integrated circuits (RFICs) and systems, RF materials & characterization, Sensor fusion, Neurosensing, Signal processing, THz communications, Flexible and Wearable electronics, RF energy harvesting, and Textile electronics.

The RFCOM Lab has an extensive array of RF equipment. More than 5 network analyzer systems are available and operate from 10 MHz to 115GHz. Materials measurement capability is also available either using commercial analyzers or in-house fixtures for broadband and higher frequency characterization. An indoor anechoic chamber to support research in antennas, remote sensing, photonics, RF integrated circuits, and wireless systems planning. The RFCOM Lab at FIU also contains wide variety of measurement and test equipment for implementing 5G communication systems and beamforming systems. This lab also has a probe station for measuring devices at mm-wave. It is equipped with the latest state-of-the-art MIMO test equipment from Keysight technologies capable of supporting bandwidths up to 6GHz and analyzed using the SYSTEMVUE software. In addition, there are also major activities in medical sensors, RFIDs, terahertz, and textile electronics as well as ink-printing, 3D printing and microwave etching facilities. There is also access to commercially available software: HSPICE, ADS, CADENCE, HFSS, FEKO, CST, XFDTD etc.

In addition, the FIU RFCOM lab contains wide variety of measurement and test equipment's for implementing 5G communication system and beamforming systems. This lab also has a mmWave probe station for measuring communication systems at mmWave. It is equipped with the latest state-of-the-art MIMO test equipment from Keysight technologies capable of supporting bandwidths up to 6GHz and analyzed using the SYSTEMVUE software. **List of Typical equipment in RFCOM**

- LPFK ProtoLaser for high density circuit fabrication
- LPFK ProtoMat S103 for RF circuit fabrication
- N5225A PNA Microwave Network Analyzer, 50 GHz
- E4421B ESG-A RF Analog Signal Generator N5181A MXG RF Analog Signal Generator (100M-6GHz)
- E5061B network analyzer 5Hz-3GHz
- E5071C Network Analyzer 20GHz
- HP 8510, network analyzer systems
- Portable N9923A FieldFox RF Vector network analyzer
- StarLab Near-Zone Anechoic Chamber 18 GHz
- Anechoic Chamber: ETS-Lindgren's Model AMS-8050: 650 MHz to 18 GHz operation
- Film Printing/Prototyping: Fujifilm DMP-2831
- The LPKF ProtoMat S103 Circuit board plotter for producing PCB prototypes
- MAKERBOT 3D Printer Z18 3D PRINTER
- N52222A with operation up to 110 GHz
- VDI Tx/Rx extenders up to 110GHz for mmWave systems

- 33622A Waveform generator – Dual channel 120 MHz

Applied Research Center (ARC) laboratories at FIU Engineering Center

Cyberspace Technology Testing and Training Center (CT3C): FIU's Applied Research Center (ARC) is supporting the Department of Defense (DOD) - Test Resource Management Center (TRMC) in its mission to plan, assess and test cyberspace technology development, acquisition, fielding, and sustainment of defense systems for the Major Range and Test Facility Base (MRTFB). CT3C performs cyberspace technology research, testing and training of workforce through a multi-disciplinary STEM program at FIU. ARC has established the lab in its facility with state-of-the-art servers, security tools and network infrastructure to simulate, monitor and provide response to real life security threats. CT3C optimizes resource allocation, monitoring and provisioning for proactive threat prevention to mitigate network and infrastructure risks. CT3C performs testing and evaluation of cyberspace technologies, Malware Monitoring & Analysis, Machine Learning, Cyber Analytics & Visualization.

Artificial Intelligence (AI) and Big Data Lab: FIU's Applied Research Center (ARC) has built Artificial Intelligence and Big data hub to support challenging research tasks in the area of structural health monitoring of the nuclear infrastructure for the Department of Energy (DOE) – Environmental Management. AI lab infrastructure consists of GPU and CPU servers to analyze large size sensor and imagery datasets using deep learning and machine learning algorithms.

Malware Forensics Lab: FIU's Applied Research Center's Malware Forensics lab consists of server to Host variety of penetration testing, malware forensics and Ethical hacking tools to perform various cyber security tasks. Malware lab also has the infrastructure to develop custom malwares used for the cyber test technology, test, and evaluation (T&E).

Advanced Material Engineering Research Institute (AMERI): AMERI provides analytical instrumentation, materials characterization and micro/nano process and device development laboratories to support faculty and industry in the development and characterization of new materials over the continuum from the nanoscale to bulk materials. The AMERI specializes in the realization of high-tech solutions to solve advanced technological problems for research, product development, and analysis. Combining customer specific needs and input with advanced analytic tools, design, fabrication, and testing. The AMERI offers a multi-faceted approach to achieve needed results.

Wall of Wind (WOW): The NHERI WOW EF is powered by a combined 12-fan system capable of repeatable testing in up to 157 mph wind speeds through its flow management system. The unique advantage of the NHERI WOW EF is multi-scale (full-scale to 1:400) and high Reynolds number simulation of the effects of wind and wind-driven rain. This is accomplished using the twelve fans and a water spray system. In addition, the 16,000 sqft. fenced-off secure area enables researchers to plan and perform destructive tests for up to Category 5 Hurricane wind speeds.

Past Performance: From life-saving enhancements in healthcare technologies to innovations in space exploration, advancements in communications to groundbreaking inventions in biomedical engineering and artificial intelligence, FIU engineers are on the cutting-edge, progressively

developing a myriad of innovations in direct response to real-world problems. $45M total annual research awards FY 2020, $275k per principal investigator and 50 research laboratories, centers, and institutes.