CMNST Research Capability Statement
Dr. Noureddine Melikechi, Dean

The College of Mathematics, Natural Sciences & Technology, also known as the CMNST, is comprised of five (5) academic units actively engaged in cutting-edge research: Biological Sciences, Chemistry, Computer & Information Sciences, Mathematical Sciences and Physics & Engineering. Faculty researchers engage in interdisciplinary research that spans such topics as biomedical and biochemical research, environmental chemistry and renewable energy research, computational and applied mathematical applications, biophysics and laser optics research. Two auxiliary units support on-campus research activities of the CMNST, as well as other Colleges on-campus, external collaborators, and customers: the Imaging Facility and Machine Shop. The College is also home to the Army ROTC/Air Force ROTC unit.

I. BIOMEDICAL RESEARCH & BIOCHEMISTRY

Biomedical research is, by nature, a collaborative and interdisciplinary endeavor. This is particularly the case within the College of Mathematics, Natural Sciences and Technology, where current research projects are reaching across multiple departmental – and college – lines. One such effort is the Delaware (DSU) INBRE III grant, which aims to build upon the previous successes of INBRE I and II by furthering the statewide effort to strengthen the biomedical research and education network within the Delaware region. Funded by the NIH, research projects are conducted in one of three focus areas: Cardiovascular, Cancer, and Neuroscience.

Another prominent program is the Delaware Center for Neuroscience Research (a COBRE grant). This NIH-funded effort is aimed at supporting neuroscience research projects, further strengthening intra-state neuroscience education, as well as encouraging meaningful collaboration among the region’s burgeoning neuroscience research community.

The Laboratory for Chemical Genomics engages in the development of clinical applications utilizing nanofiber scaffolds as patches for implantation of gene edited cells into human tissues. This award-winning lab is known for being a pioneering force in the development of using these specialized, single-strand DNA oligonucleotides (ODNs) for the treatment of inherited disorders such as sickle-cell anemia.

Selected researchers and areas of interest:

Melissa A. Harrington, Ph.D.
Biological Sciences Department
mharrington@desu.edu
Areas of research interest: Neuroscience

Eric B. Kmiec, Ph.D.
Chemistry Department
ekmiec@desu.edu
Areas of research interest: Biochemistry, molecular biology and clinical implications of gene editing in human cells

Cheng-Yu Lai, Ph.D.
Chemistry Department
cylai@desu.edu
Areas of research interest: Imageable multi-drug delivery carriers to eliminate cancer and cancer stem cells

Qi Lu, Ph.D.
Physics & Engineering Department
qilu@desu.edu
Areas of research interest: Molecular interactions of biopolymers and nanomaterials, biomolecular interactions in complex media, electrical and photonic transport in carbon nanotubes

Dula Man, Ph.D.
Chemistry Department
dman@desu.edu
Areas of research interest: Nanomaterial engineering for biomedical applications

Daniela R. Radu, Ph.D.
Chemistry Department
dradur@desu.edu
Areas of research interest: Nanomedicine

Above: Student in a biological science laboratory
II. ENVIRONMENTAL CHEMISTRY AND RENEWABLE ENERGY RESEARCH

Environmental chemistry and renewable energy research is a growing capability within our College. Faculty researchers are currently investigating hydrogen storage materials, biosensing using laser-based photonic sensors and identifying environmental behaviors of organic contaminants in the environment and their biological impact on the ecosystem.

Research in the Renewable Energy Research and Education Center focuses on utilizing municipal solid waste for renewable energy production and environmental monitoring. One point of investigation is the use of municipal solid waste to generate methane gas and biodiesel as part of green energy production. A second research interest involves the use of laser-based technologies for monitoring landfill leachate and detection of trace amounts of gases present in a bioreactor landfill.

Selected researchers and areas of interest:

Andrew Goudy, Ph.D.
Chemistry Department
agoudy@desu.edu
Areas of research interest: Investigation of hydrogen storage materials

Mohammad A. Khan, Ph.D.
Physics & Engineering Department
mkhan@desu.edu
Areas of research interest: Laser-based photonic sensors, sensor networks to measure greenhouse gases for environmental sensing, global climate change and industrial applications

Cheng-Yu Lai, Ph.D.
Chemistry Department
cylai@desu.edu
Areas of research interest: Detection of emerging organic pollutants at nano and picomolar level; biodiesel research

Daniela R. Radu, Ph.D.
Chemistry Department
dradur@desu.edu
Areas of research interest: Solar materials for inorganic thin-film solar cells; nanocrystal arrays for continuous hydrogen generation

Mukti T. Rana, Ph.D.
Physics & Engineering Department
mrana@desu.edu
Areas of research interest: Uncooled infrared, microsensors, biosensing, solid waste for bio-gas production

Qiquan Wang, Ph.D.
Chemistry Department
qwang@desu.edu
Areas of research interest: environmental behaviors of organic contaminants in the environment and impacts on the ecosystem

Above: Interdigitized electrodes for bio-sensing and drug delivery
III. Computational Intelligence and Applications in Mathematics Research
Computational Intelligence is another growing field of interest within our College. Recent work involves the development and analysis of algorithms, computational geometry, simulation and analysis of medical images, machine intelligence, as well as surveillance and video analytics. One lab, CIBiL – the Computational Intelligence and Bio (logical) informatics Lab – for instance, applies various computational intelligence methods to solve problems in the field of biological science. The Laboratory for Intelligent Perceptual Systems (LIPS) is investigating machine learning, and is currently engaged in researching the development of protocols that marry intelligent monitoring of home care patients having chronic illness (robotics) with delivery of timely interventions to prevent further patient deterioration.

Meanwhile, research competencies have paired our researchers with neurobiologists, medical physicists, imaging scientists, and entities such as the Department of Defense, the National Science Foundation, and the State of Delaware Department of Transportation – just to name a few. Ongoing research into cyber security has resulted in paper publications that have garnered national attention, as collaborations with the University of Pennsylvania, Temple University, and the US Food and Drug Administration have brought about valuable strides in performing analysis and simulation of medical images to improve breast imaging in the medical field and to investigate the neurobiology of sensory processing and learning in an invertebrate model system.

The Applied Mathematics Resource Center (initially established with grants by the Department of Defense (DoD) has been fertile ground, research-wise, for advances in the application of advanced mathematical logarithms and physics in ground-penetrating radar technologies, image and signal-processing, computational geometry, biomathematics and biotechnology.

Selected researchers and areas of interest:

**Gary Holness, Ph.D.**
Computer & Information Sciences Department
gholness@desu.edu
*Areas of research interest: Machine learning, machine perception; robotics; cyber-physical systems*

**Hongxin Hu, Ph.D.**
Computer & Information Sciences Department
hhu@desu.edu
*Areas of research interest: Cybersecurity; information security and privacy*

**Jinjie Liu, Ph.D.**
Mathematical Sciences Department
jliu@desu.edu
*Areas of research interest: Computational fluid dynamics and nonlinear optics*

**David D. Pokrajac, Ph.D., MBA**
Computer & Information Sciences Department
dpokrajac@desu.edu
*Areas of research interest: Algorithms, simulation and analysis of medical images, machine learning and video analytics*

**Tomasz G. Smolinski, Ph.D.**
Computer & Information Sciences Department
tsmolinski@desu.edu
Areas of research interest: Exploration and analysis of large parameter spaces of neuronal models

Above: Faculty member, student and robot

Above: Faculty and students at 2013 Delaware U.S. Cyber Challenge
IV. IMAGING, LASER OPTICS RESEARCH AND BIOPHYSICS

Optics is perhaps one of the most prolific research application program areas on campus. DSU has the unique distinction of being the only HBCU having an optical science PhD program on its campus, with its optics program counted as one of less than 10 located in the United States – currently the only one on the Eastern seaboard. DSU will also be home to the site of a new, multi-million dollar optics research facility. The Optical Science Center for Applied Research (OSCAR) engages in collaborative research with entities such as the Fox Chase Cancer Center, Northwestern University and Los Alamos National Laboratory to promote innovation through the use of optics and laser-based applications to bioscience, drug delivery, biophysics, and biosensing within the environment. Of notable achievement, NASA-affiliated research has thrust our researchers into the spotlight as instrumentation designed by our scientists has been utilized in the 1st ever detection of water on the planet Mars.

Selected researchers and areas of interest:

Hacene Boukari, Ph.D.
Physics & Engineering Department
hboukari@desu.edu
Areas of research interest: fluorescence imaging, spectroscopy, light scattering, neutron scattering

Mohammad A. Khan, Ph.D.
Physics & Engineering Department
mkhan@desu.edu
Areas of research interest: Development of novel laser based photonic sensors, measuring greenhouse gases for environmental sensing

Noureddine Melikechi, D. Phil.
Physics & Engineering Department
nmelikechi@desu.edu
Areas of research interest: Laser optics, optical science applications research

Thomas A. Planchon, Ph.D.
Physics & Engineering Department
tplanchon@desu.edu
Areas of research interest: Laser optics and light-based imaging technologies for study of 3-D cellular processes in living cells and biological specimens

Above: Graduate student researchers in an optics research lab
Above: Faculty, staff and participants from the 2013 OSCAR Summer Research Program