Research in EE: Labs & Centers

https://www.eecs.mit.edu/research

Research Laboratory of Electronics (RLE)

http://www.rle.mit.edu

Major Themes: 7 Areas of Focus

- Atomic Physics
- Information Science and Systems
- Quantum Computation and Communication
- Energy, Power, and Electromagnetics
- Photonic Materials, Devices, and Systems
- Nanoscale Materials, Devices, and Systems
- Biomedical Science and Engineering

Microsystems Technology Laboratories (MTL)

http://www-mtl.mit.edu/index.html

Research Centers & Initiatives

- Center for Integrated Circuits and Systems (CICS)
- Medical Electronic Device Realization Center (MEDRC)
- MIT/MTL Center for Graphene Devices and 2D Systems (MIT-CG)
- MIT/MTL Gallium Nitride (GaN) Energy Initiative (MIT-GaN)

Laboratory for Information and Decision Systems (LIDS)

https://lids.mit.edu

Core Engineering Disciplines

- Systems, networks, and control
- Communications, transmission of information, and networks
- Inference and statistical data processing

Summer 2017 UROP Opportunities

The projects listed below have been advertised by professors seeking UROP student researchers for Summer 2017. The UROP program is open to all undergraduates. **Freshmen and sophomores are highly encouraged to apply!**

Please note that the deadline to submit applications for Summer 2017 UROPs with *Direct Funding* is **April 13, 2017 at 5:00pm**.

Department / Lab / Center: EECS (Course 6) / LEES / RLE
Faculty Supervisor: Steven Leeb
Group URL: http://www.rle.mit.edu/lees/

Project Title: Electromechanical Systems

Project Description: see http://web.mit.edu/cdev2/

Department / Lab / Center: EECS (Course 6), BE (Course 20) / RLE
Faculty Supervisor: Jongyoon Han
Group URL: http://www.rle.mit.edu/micronano/

Project Title: Building portable centrifuge

Project Description: We will build a small portable microfluidic system that can support the function of standard centrifuge on the field, for medical diagnostics in the third world, resource-limited setting. This

project involves working with postdoc supervisor to build a control unit and microfluidic systems, as well as to carry out other necessary engineering, with the goal of building prototypes that can be deployed in many field sites.

Department / Lab / Center: EECS (Course 6) / RLE
Faculty Supervisor: Jongyoon Han
Group URL: http://www.rle.mit.edu/micronano/

Project Title: Portable desalination system engineering

Project Description: In this UROP project, we will build a small scale (portable) electrical desalination system that can desalinate seawater, and will test the efficiency and other metric with natural seawater and other source water. This project will involve ample opportunity to exercise hands-on engineering skills, to assemble the unit and design control system.

Department / Lab / Center: EECS (Course 6) / RLE
Faculty Supervisor: David Perreault
Group URL: http://www.rle.mit.edu/per/

Project Title: Switched Capacitor and Hybrid Switched-Capacitor/ Magnetic Power Conversion Demonstration Systems

Project Description: The design and performance of power electronics (energy conversion circuits) has been rapidly advancing in recent years. One notable development has been the emergence of switched-capacitor (SC) converters and hybrid magnetic/SC converters that provide excellent efficiency and performance. This UROP project will be to develop a set of demonstration converters for use in MIT classes that can illustrate the

operation and characteristics of SC and hybrid converters. As "demo" circuits are used for many years (typically more than a decade, and sometimes up to 40 years!), the developed circuits must be very well thought out and robustly designed, and their design and use must be well documented. Designing, constructing, validating and documenting these circuits will provide the UROP student with a strong understanding of circuit operation, design, fabrication, and testing principles, and will provide a lasting legacy benefiting future generations of students.

Department / Lab / Center: EECS (Course 6) / RLE
Faculty Supervisor: Dirk Englund
Group URL: http://www.rle.mit.edu/qp/

Project Titles:
- Advanced Real-Time Infrastructure for Solid-State Quantum Memories
- Single Photon Emitters in Diamond
- Advanced NV-Cavity Designs
- Diamond NV-center spontaneous emission and collection enhancement by metallic antennas
- Graphene super-detectors & Robotic Microscopy for Qubit Factory

---

This is *not* an exhaustive list of UROP openings in EE labs. Students are encouraged to explore their interests, browse through group websites, and reach out to professors and/or graduate student supervisors about opportunities.

Additional UROP Openings

Advertisements for UROP opportunities in all departments are regularly posted on the MIT UROP Project Openings website:

http://web.mit.edu/urop/research/openings.html

Many of these projects are interdisciplinary and some EE projects may be advertised by labs in departments other than Course 6. Several EE-related projects for Summer 2017 are shown here:

Please note that the deadline to submit applications for Summer 2017 UROPs with *Direct Funding* is **April 13, 2017 at 5:00pm**.

Department / Lab / Center: Health Sciences and Technology (HST)
Faculty Supervisor: Elazer Edelman

Project Title: Build control system for a custom mechanical rig for testing bioresorbable scaffolds

Project Description: Cardiovascular stents are implanted in millions of patients each year. The most advanced technology utilizing bioresorbable to eliminate long term concerns associated with metal stents. However, it leads to a higher rate of clinical failures. Our work seeks to understand the dynamic behavior of these devices to provide insights for future device development. There is an opening for an undergraduate interested in control systems, system level circuit building, programming and image acquisition and processing. The control system will direct function of a mechanical strength testing configuration. The project will involve hands-

on experimentation and assembly of trial designs both mechanical and electrical.

Prerequisites: System design, programming (C#) and circuit building experience are preferred. Ability to read electrical drawings and good documentation skills are also preferred. Candidates must be reliable, organized, and independent with strong communication skills. Please send a pdf of your CV.

Contact Name: Peijiang Wang (wpj@mit.edu)

Department / Lab / Center: ME (Course 2)
Faculty Supervisor: Klavs Jensen (kfjensen@mit.edu)
Group URL: http://web.mit.edu/jensenlab/research/chemistry/

Project Title: Collaborative flow chemical synthesis robot

Project Description: We are developing a robotically reconfigurable chemical synthesizer utilizing microfluidics. The two unique capabilities are decentralized reaction modules for chemical synthesis monitoring and a novel fluidic manifold / reactor interface for robotic manipulation. This work is being carried out by a cross-disciplinary team (mechanical engineering, electrical engineering, chemical engineering) focused on overcoming limitations of chemical synthesis through the design of reactor modules which have integrated control electronics and process analysis technology to collect data and optimize reactions. UROPs will be involved with the design and testing of new parts, electronic circuits, and components. We are also working on developing a new user interface for path planning and optimization reactor stacking. The output of this projects is a robot that can make any pharmaceuticals on-demand.

Potential tasks include:

- Prototyping circuits for controlling process parameters (Arduino, PSoC)
- Utilization of Bluetooth low energy
- Control through PID
- PCB boards
- Developing control interface for collaborative robot (UR3) in LabVIEW, Matlab, or Python
- Design and testing of new reactor designs

Prerequisites: The major requirements are motivation and an eye the detail. Knowledge of (or interest in) programming an Arduino/PSoC, experience with LabVIEW/Matlab/Python for UI development, mechanical component design experience would also be helpful (solidworks, 3dp).

Contact Name: Dale Thomas (dt3@mit.edu)

Department / Lab / Center: Health Sciences and Technology (HST)
Faculty Supervisor: Jose Gomez-Marquez

Project Overview: The Little Devices lab of researchers turns toys into medical devices for international and domestic healthcare systems using design strategies such as affordability, modularity and DIY. Our lab aims to design technology that is robust and economical, yet intelligent using advanced sensors and smart materials. Projects from the group have been launched in Germany, Ecuador, Nicaragua, Ethiopia and New Zealand. The work has been featured by the New York Times, Wired, CNN, and TED.

Project Title: Programming and Building Hardware: Biosensors for Digital Health Divides (Course 2, 6, 20, 4)

Project Description: Design and test a suite of biosensors for physiological and biological parameters. Successful designs will plug and

play with the rest of our prototyping platform and will be easily embeddable into unconventional diagnostic systems.

Prerequisites: Experience with designing, prototyping (such as Arduino) testing and debugging electronic circuits (e.g. embedded systems combining analog circuitry, digital circuitry, microcontrollers and wireless communications). Experience with wireless sensors or protocols helpful (e.g. Bluetooth, WiFi).

Contact: Please send your CV and statement of interest to littledevices@mit.edu.

Department / Lab / Center: Media Laboratory
Faculty Supervisor: Hiromi Ozaki

Project Title: Electrical Engineering for Mind Control Microorganisms Through Galvanotaxis

Project Description: Looking for passionate EE engineers to work on a project translating the EEG signals from the brain to a system used to control the movement of microorganisms through an electric felid. We are looking for an EE student to design a circuit that controls electric fields.

Prerequisites: Must be fluent in electrical engineering. Experience designing and fabricating PCBs a must. Experience with programming for wearable sensors a plus, familiarity with microorganisms a plus. Must be able to devote 5+ hours a week and meet weekly. UROP for credit only.

Contact Name: Ani Liu (wonder@mit.edu)

2017-2018 SuperUROP Projects

The projects listed below have been advertised as part of the 2017-2018 Course 6 SuperUROP program. This program is open *only* to juniors and seniors.

For more information about the SuperUROP program, visit https://superurop.mit.edu/.

For a more complete listing of projects along with their descriptions and faculty/mentor contact info, visit https://superurop.eecs.mit.edu/searches/searches.tcl?dept=eecs.

Project Title: Development of Photonic Nanocavities for Extreme Light-Matter Interaction
Faculty Supervisor: Dirk R Englund
Research Areas: Applied Physics, Numerical Methods, Signals and Systems, Theoretical Computer Science

---

Project Title: High-fidelity microwave electronics and machine learning for high-fidelity quantum gates on semiconductor spins
Faculty Supervisor: Dirk R Englund
Research Areas: Applied Physics, Artificial Intelligence, Circuits, Control, Nanotechnology, Signals and Systems, Theoretical Computer Science

---

Project Title: Developing a QubitFoundry
Faculty Supervisor: Dirk R Englund
Research Areas: Applied Physics, Artificial Intelligence, Computer Systems, Graphics and Human-Computer Interfaces, Nanotechnology

---

Project Title: THz Image Sensors with Electronic Beam Forming
Faculty Supervisor: Ruonan Han
Research Areas: Circuits, Signals and Systems

Project Title: Highly-Stable On-Chip Clock: Characterization and Electronic Design
Faculty Supervisor: Ruonan Han
Research Areas: Applied Physics, Circuits, Materials and Devices, Signals and Systems

---

Project Title: THz Spectroscopy for Molecule Sensing and Identification
Faculty Supervisor: Ruonan Han
Research Areas: Applied Physics, BioEECS, Circuits, Materials and Devices, Nanotechnology, Signals and Systems

---

Project Title: GaN probes for opto-genetics
Faculty Supervisor: Tomas Palacios
Research Areas: BioEECS, Materials and Devices, Nanotechnology

---

Project Title: Wearable biochemical sensors based on graphene
Faculty Supervisor: Tomas Palacios
Research Areas: Materials and Devices, Nanotechnology

Project Title: New approaches for thermal management in GaN electronics
Faculty Supervisor: Tomas Palacios
Research Areas: Materials and Devices

Project Title: Long-Distance Quantum Communication with Diamond Spin Qubits
Faculty Supervisor: Dirk Englund
Research Areas: Applied Physics, Control, Materials and Devices, Nanotechnology, Numerical Methods

---

Project Title: Developing High-Speed FPGA Architecture for Quantum Cryptography
Faculty Supervisor: Dirk Englund
Research Areas: Applied Physics, Circuits, Communications, Control, Nanotechnology, Numerical Methods, Signals and Systems

---

Project Title: Quantum Plasmonic Interface Between Photons and Spins
Faculty Supervisor: Dirk Englund
Research Areas: Applied Physics, Nanotechnology

Project Title: Scalable integration of high-performance lasers for on-chip quantum information processors
Faculty Supervisor: Dirk Englund
Research Areas: Applied Physics, Nanotechnology

Project Title: Designing Quantum Plasmonic Devices
Faculty Supervisor: Dirk Englund
Research Areas: Applied Physics, Materials and Devices, Nanotechnology, Numerical Methods, Theoretical Computer Science

---

Project Title: Hydration monitoring in a wearable wristband
Faculty Supervisor: Luca Daniel
Research Areas: Applied Physics, BioEECS, Circuits, Materials and Devices, Numerical Methods

---

Project Title: Low Cost Micromanipulator
Faculty Supervisor: Joe Steinmeyer
Research Areas: BioEECS, Circuits, Control

Project Title: Learning Causal Graphs and Applications to Gene Regulation
Faculty Supervisor: Caroline Uhler
Research Areas: Artificial Intelligence, BioEECS, Control, Numerical Methods, Signals and Systems, Theoretical Computer Science

---

Project Title: Learning Brownian Motion Trees and Applications to Cell Differentiation
Faculty Supervisor: Caroline Uhler
Research Areas: BioEECS, Numerical Methods, Signals and Systems, Theoretical Computer Science

---

Project Title: Ellipsoid Packing and Applications to Chromosome Organization
Faculty Supervisor: Caroline Uhler
Research Areas: Applied Physics, Artificial Intelligence, BioEECS, Control, Numerical Methods, Signals and Systems, Theoretical Computer Science

---

Project Title: Decoding visual information from the human brain
Faculty Supervisor: Aude Oliva
Research Areas: Applied Physics, Artificial Intelligence, BioEECS, Circuits, Signals and Systems

---

Project Title: Quantum CMOS Design
Faculty Supervisor: Rajeev Ram
Research Areas: Applied Physics, Materials and Devices, Nanotechnology, Numerical Methods

---

Project Title: Computational Spectroscopy
Faculty Supervisor: Rajeev Ram
Research Areas: Applied Physics, Signals and Systems

Project Title: Rapid Blood Analysis
Faculty Supervisor: Rajeev Ram
Research Areas: Applied Physics, BioEECS, Signals and Systems

---

Project Title: Secure IoT
Faculty Supervisor: Prof. Anantha Chandrakasan
Research Areas: Communications, Computer Systems

Project Title: An Energy-Efficient FPGA Computer Vision platform for Real-time Object Detection
Faculty Supervisor: Vivienne Sze
Research Areas: Artificial Intelligence, Circuits, Computer Systems, Signals and Systems

---

Project Title: Billion-fold biomolecule preconcentrator for TB diagnostics
Faculty Supervisor: Jongyoon Han
Research Areas: Applied Physics, BioEECS, Materials and Devices

---

Project Title: Second Generation Physiologic Sensors for Low-Income Countries
Faculty Supervisor: Roger Mark
Research Areas: BioEECS, Materials and Devices, Signals and Systems

---

Project Title: Portable Centrifuges
Faculty Supervisor: Jongyoon Han
Research Areas: Applied Physics, BioEECS, Materials and Devices

---

Project Title: Portable Seawater Desalination System
Faculty Supervisor: Jongyoon Han
Research Areas: Applied Physics, Control, Energy, Materials and Devices

Project Title: 3D electronics based on III-V semiconductors
Faculty Supervisor: Jesus A. del Alamo
Research Areas: Applied Physics, Materials and Devices, Nanotechnology