Credits and Contact Hours:  
5 Credits (3 credits in the fall and 2 credits in the spring) 
Fall semester schedule: Friday 1-6 pm (with a lecture 1-3 pm; Kelley Hall room 216

Instructor’s Name:  
Section 1: Prof. Ying Sun, sun@ele.uri.edu, 401-874-2515  
Section 2: Dr. Eugene Chabot, <eugenchabot@gmail.com>  
Section 3: Dr. Jiang Wu, <house.jw@gmail.com>  
BME Technician: Tanya Wang <twang@ele.uri.edu>

Textbook: None. Using materials from previous courses (particularly BME 361 Biomeasurement laboratory and BME 363 Biomedical Instrumentation Laboratory), documentations on relevant projects, data sheets, relevant journal and conference papers, and Internet resources.

Course Information: Applications of engineering skills; team projects in biomedical areas such as neuroengineering, assistive technology, cardiopulmonary measurements, medical imaging, and modeling of physiological systems. Two-course sequence. Prerequisites: BME 207 and BME 362.

Generalized and ABET Student Outcomes

Generalized Student Outcomes
- To Understand – Describe the design process, performance specifications, functional requirements and constraints. Define the design problem.
- To Question – Evaluate design alternatives.
- To Design - Design software and hardware to meet performance specifications, functional requirements, and constraints.

ABET Student Outcomes and Data to be Analyzed
C: Constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. Data analysis: design with realistic constraints from the ABET outcome essay.
D: Ability to function on multi-disciplinary teams. Data analysis: multi-disciplinary teamwork from the ABET outcome essay.
J: Knowledge of contemporary issues. Data analysis: relevance to contemporary issues from the ABET outcome essay.
L: Ability to think critically about design alternatives and tradeoffs. Data analysis: design alternatives and tradeoffs from the ABET outcome essay.

Course Assessment Methods
1. Project management & design process – 10%
2. Mid-year progress report – 20%
3. Project prototype – 30%
4. Conference paper, grant proposal, & IRB application (if applicable) – 20%
5. Final Report and documentation – 20%

Grading Scale
A 94-100  
A- 90-93  
B+ 87-89  
B 83-86
B- 80-82  
C+ 77-79  
C 73-76  
C- 70-72  
D+ 67-69  
D 60-66  
F <60
BME 484 Activities

In the fall there are 2 lecture hours plus a 3-hour lab section. In the spring the number of lecture hours is reduced to 1. There is a multitude of activities that need to be initiated and organized in the fall semester, which include:

- Forming a multidisciplinary team and assigning job functions
- Project topic identification and specifications
- Project proposal and design process specifications
- Prototype development and research
- IRB approval (for some teams)
- Undergraduate Research Initiative grant proposal development (usually due in November)
- Presentation at the Assistive Technology Conference (usually in November)
- 2-page paper for Northeast Bioengineering Conference (usually in February)

Topics Covered

- Design Process
- Defining the Customer’s Design Problem
- Performance Specifications, Functional Requirements
- Evaluating Design Alternatives
- Design Implementation and Project Timeline
- FDA Guidelines, the Design History File
- IRB approval for human study
- Engineering Ethics and Obligations
- Innovation, patent application, entrepreneurship
- Presentations professional conferences

Project Topics – Project topics vary from year to year. They are recommended to students and address one or more of the following ABET criteria for BME:

- Solving the problems at the interface of engineering and biology.
- Developing the ability to make measurements on and interpret data from living systems.
- Addressing the problems associated with the interaction between living and non-living materials and systems.

Timeline

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1. Team & topic
2. Design
3. IRB application (if applicable)
4. Mid-year progress report
5. Project prototype
6. Testing & improvement
7. NEBEC Conference paper
8. Grant proposal (TBA)
9. NEBEC Conference (TBA)
10. Final Report
1. Team & topic – team formation, job assignment, preliminary specifications, resources.
3. IRB application – applicable to projects having a human study component.
5. Project prototype – hardware, software, mechanical parts, packaging.
7. NEBEC Conference paper – usually due 2/1/16.
8. Grant proposal (Undergraduate Research Initiative Awards) – TBA, usually in Nov. and March.

Students with Disabilities
Any student with a documented disability is welcome to contact me as early in the semester as possible so that we may arrange reasonable accommodations. As part of this process, please be in touch with Disability Services for Students Office in Memorial Union, room 330 or phone 874-2098.
BME 484/485 Capstone Design Recommended Projects 2015-2016

The following projects have Dr. Ying Sun as the lead supervisor:

1. Transcranial-magnetic Stimulation (TMS) Helmet (MagnetPeutics)
   This project is co-supervised by Dr. Brian Silver (a neurologist) of RI Hospital to develop a portable helmet with permanent magnets for the rehabilitation of stroke patients. The magnets need to be flipped every, say, 30 minutes, which could be done either manually or by small battery-powered motors. The engineering techniques involve 3D printing and PIC microprocessor controls of motors. A human study in collaboration with RI Hospital is to be conducted.

2. Ride-on Cars for Children with Disabilities (Ride-On)
   This project aims at adapting ride-on cars for children with mobility impairments, allowing them to better interact with peers & improve muscle strength & coordination. Each car will be custom adapted for each child's specific needs. We hope that this will increase each child's confidence and encourage them to actively participate in social interactions. The technical components may include a collision avoidance device based on ultrasound detectors and PIC processor. This project is in collaboration with Nursing graduate students Sandra Maliangos and Coral Hines.
   Video of concept: https://www.youtube.com/watch?v=qcZtW18VgLg
   Sample Instruction Manual: www.udel.edu/PT/About%20Us/People/Galloway/GoBabyGoManualMcQueenStepByStep.pdf

3. Stove Barrier for Burn Prevention in Africa (StoveFence)
   This project is co-sponsored by Dr. Shahla Yekta (URI Nursing) who is the lead scientist of the “Burn Prevention-Africa” project funded by the United Nations <http://www.uofplasticsurgery.ca/donate/case-studies/burn-prevention-africa/>. Many children in the slums of Kenya have suffered from burns over coal stoves used inside their living areas. A prototype of the stove fence has been developed by Prof. Sun. This project aims at adding a mesh lid to the fence, identifying locally-available alternative materials, and reducing costs.

4. 3D Tissue Culture Platform (3DTissue)
   This project is brought to us by Prof. Samantha Meenach of Chemical Engineering: “I'm looking for some students who can help design a tissue culture platform for the research our group is doing. We are growing 3D tumor spheroids in partial air culture. Since this has never been done before, there isn't a good way to do this in a high throughput fashion at this point. I'm afraid this would be heavy into 3D printing although there may be some other options. Another aspect we could look into is if there is a way to measure some sort of response from the spheroids that relates to their size and or viability as chemical measurement isn't possible and imaging is cumbersome.”

5. Wrist Pulse Simulator (PulseSim)
   This project is in collaboration with Dr. Mona Boudreaux and Prof. Faye Boudreaux-Barcel. Pulse diagnosis is an important technical for diagnosing various diseases in the traditional Chinese medicine (TCM). Using three fingers to feel the pulses at the wrist, an expert in TCM can detect up to 29 different pulse patterns. This project is aimed at developing a wrist pulse simulator to teach pulse diagnostic techniques.
The following projects have Dr. Eugene Chabot as the lead supervisor:

6. **Smartphone Based Balance Board Rehabilitation Device** (iWobble)
   This project is co-supervised by a physical therapist. A smartphone has been incorporated into a wobble board to report real-time ankle attitudes during ankle sprain rehabilitative treatment. The original design from requires further development and perhaps a redesign of the front-end embedded in the wobble board.

7. **Smartphone Based Physiological Monitoring for Firefighters** (WiFire)
   Using the PIC and the Android smartphone platforms to develop a physiological monitoring system (just the heart rate to begin with). A warning signal is sent out by the phone if the heart rate is outside a predefined normal range. Additional physiological and environmental signals can be incorporated, such as breathing rate, SaO2, activity level, temperature, CO2 level, CO level, and location from GPS.

8. **Age Assessment by Heart Rate Variability** (HRAge)
   There should be a correlational relationships between heart rate and age-related autoregulation. This project aims at developing a smartphone based device and a model for assessing the age in terms of heart rate variability (HRV) by establishing a database from subjects over a broad age range. Two exercises are performed to vary the heart rate: 1) standing up suddenly and 2) forced exhaling against a closed airway (the Valsalva maneuver). In both cases, the heart rate should increase and the HRV is indicative of the autoregulatory sensitivity. In general, the HRV decreases as age increases (causal relationship). There should be a correlational relationship between standing up and forced exhaling. As shown in the figure, an app allows the students to design and develop a predictive model by collecting HRV data from multiple persons. Additional data such as body mass index (BMI) and sex can be collected to increase the model's predictability for the age.

9. **Android Based Visual Sensory Substitution Device** (VisualSub)
   This device relays motion information to an Android based Smartphone through the sense of touch. An Android App implements real-time image processing where motion is translated to vibrations using buzzers that are located in a belt that the user will wear around their waist. This assistive technology promotes the visually impaired to have greater independence and restore their freedom.

The following projects have Dr. Jiang Wu as the lead supervisor:

10. **An Electronic Model and Parameter Estimation for Cell Capacitance** (CellCap)
    Exocytosis and endocytosis are important mechanisms for a cell to transport substances in and out. This is typically done by forming vesicles that carry substances through the cell membrane. When a vesicle crosses the cell membrane, the surface area of the cell momentarily increase, which can be observed by monitoring cell capacitance with an electrode. This capacitance change is very small (on the order of 10 femto farads) and very difficult to measure. Dr. Sun has a novel instrument and algorithm to monitor the cell capacitance in a fast and accurate fashion. This project involves the development of a novel analog cell capacitance model, Matlab programming, and/or PIC based instrumentation.
11. **Testing of the Universal Clamp with the Neuron Emulator** (UClamp)
Universal Clamp is an innovative neuroscience instrument that has been developed at URI in collaboration with Neuroscience Tools, a St. Louis based company. This instrument uses a state-of-the-art digital signal processor (Analog Device Blackfin BF548) to interact with neurons. A prototype of the Universal Clamp has just been developed. This project involves the testing of the Universal Clamp for current clamping and voltage clamping on a previously developed neuron emulator.

12. **Imaging Based Activity Analyzer** (iActivity)
This project is sponsored by Analog Devices, Inc. (ADI) and advised by Dr. Jiang Wu. ADI will donate two units of their Blackfin Low Power Imaging Platform (BLIP) built around the ADI’s ADS-BF70X processor. Image processing algorithms will be developed to do local image/video processing for detection of occupancy, body positions, and body movements, and so on. Specific movement patterns can be used to identify situations of concern such as sudden fall, inactivity, overactivity, sedation, long-time sitting, dozing off, tremors, etc.