Course Outline

BE 7350: Advanced Instrumentation and Control for Biological Systems

Instrumentation theory [Weeks 1-2]

Sensing and measurement;
Transducers;
Analog and digital measurement systems.

Control concepts [Weeks 3-4]

Feedback loops;
Measurement;
Laplace transform methods;
Classical (analog) control theory;
Digital control theory.

Relevant properties of biological systems: [Weeks 5-6]

Spatial and temporal heterogeneity;
Stochasticity; emergent properties;
Growth;
Reproduction and death;
Trophic levels;
Environmental and ecological issues and complexity.

Advanced Instrumentation and Control: Integration: [Weeks 7-8]

Applications of Modeling and Simulation;
Adaptive Control;
Specific Examples of Design and Control Simulation Languages:
    Matlab
    Femlab
Applications in Biological Engineering.

Midterm after week 8

Project Work [Weeks 9-15]

Final Project Suggested Application Areas:

Environmental Applications: [Review Weeks 9]
Environmental monitoring: automated systems for environmental monitoring (e.g. LA State Climatology Project; Theegala-bioreactors);

Agricultural Applications: [Review Week 10]

Aquacultural Applications: Automated monitoring and control in recirculating aquaculture systems (Timmons; Hall; Malone; Rusch).
Precision or Prescription Farming: (Barbosa, Smith) GPS and GIS applications in agriculture and related areas.
Composting Applications: (Hall) Measurement and control of biodegradation systems.

Autonomous Vehicles: [Week 11] (Hall)

Improvements in autonomy of land, air and water based vehicles;
Power systems (e.g. solar photovoltaic, batteries; AC/DC power options);
Control mechanisms (e.g. servos); control processors (e.g. BASIC Stamp)

Biosensors/Biomedical: [Week 12] (Monroe, Hayes possible contributors)

Applications of instrumentation with and in biosystems.
Protein interactions "proteiomics";
Measurement of physiologically relevant variables;
Biomedical applications (Greatbatch and biomedical history).

Food and Bioprocess Engineering Automation: [Week 13] (Sabliov, Boldor possible contributors)

Automated equipment in the food processing industry;
Extrusion processes;
Rice Mill operations.

Final Projects and Presentation Due: [Weeks 14-15]

Reference Reading List
Steven G. Hall, Assoc. Professor, 578-1049 cell 281-9454.

Dally, James W., William F. Riley and Kenneth G. McConnell, 1993. Instrumentation for Engineering Measurements, Second Edition. John Wiley and Sons: New York, 584 pp.

Doeblin, Ernest O., 1990. Measurement Systems, Application and Design, Fourth Edition. McGraw Hill: New York, 960 pp.

Franklin, Gene F., J.David Powell and Michael L. Workman, 1990. Digital Control of Dynamic Systems. Addison-Wesley: Reading Mass, 841 pp.

Karnopp, Dean C., Donald L. Margolis and Ronald C. Rosenberg, 1990. System Dynamics, A Unified Approach, Second Edition. John Wiley and Sons: New York, 514 pp.

Mohsenin, Nuri N., 1986. Physical properties of plant and animal materials : structure, physical characteristics, and mechanical properties. New York : Gordon and Breach, 891 pp.

Norton, Harry N., 1989. Handbook of Transducers. Prentice Hall: Englewood Cliffs, NJ, 554 pp.

Ogata, Katsuhiko, 1990. Modern Control Engineering, Second Edition. Prentice Hall: Englewood Cliffs, NJ, 963 pp.

Omega Catalogs: www.omega.com.

Park, Joon Bu. Biomaterials : an introduction, 1979. New York : Plenum Press. 251 pp.

Parallax website: www.parallaxinc.com

Shahian, B. and Michael Hassul, 1993. Control System Design Using MATLAB. Prentice Hall: Englewood Cliffs NJ, 503 pp.

Stark, G.B. and R. Horch, 1998. Biological matrices and tissue reconstruction. New York : Springer-Verlag.

BE 7350 *Spring 2012* Course Outline

Date	Topic
1/17	Introduction, instrumentation review (Omega materials)
1/24a	Control concepts; digital mathematics
1/24b	Biological applications introduction*
1/31a	Datalogger basics
1/31b	Datalogger applications; Project Discussion*
2/7a	Analog Control Theory (P,I,D) Review*
2/7b	Digital Control Theory Review; Preliminary Project Proposals Due
2/14a	Minidataloggers: Boxcar/Hobo; Stamp; Arduino; ARM others*
2/14b	Microcontroller theory and introduction (Smith) Project Proposals Due
2/21	(Mardi Gras) Independent work on Projects
2/28a	Discussion Class: Autonomy (Smith et al) Independent work on Projects
2/28b	Control system simulation: MATLAB, SIMULINK *
3/6	Midterm, Project Updates Due
3/13a	Discussion: Biological System Properties (Hall leading)*
3/13b	Guest Lecture: Biotechnology Applications TBA
3/20a	Integration of Instrumentation, Control and Biological Systems
3/20b	Discussion: Environmental/Aquacultural Issues (student led)*
3/27a	Environmental Applications (Hall and Guests)
3/27b	Discussion: Biomed and Environmental Issues Interface (TBA)
4/3a	Discussion: Bioprocess Applications (Guests TBA)
4/3b	Discussion: Measurement and Control in the Biosphere (Guests TBA)
4/6-15	***Spring Break: Final Presentations to Follow as Shown***
4/17	Student Presentations; Ag, Env; Biomed (Students)**
4/24	Student Presentations: Biosensors; Bioprocess; Biotech (Students)**
5/1	Conclusion, Party! (under control?) Final Reports due 5/1/09

* Student presentation/facilitation of peer reviewed articles.
** Student presentations of final research reports

Possible guest lecturers include: Saidu; Smith; Hayes; Sabliov; Boldor; Theegala; Dugas, Chiu