BSE 4204: Instrumentation for Biological Systems

Fall 2016

Lecture Location: Saunders 409

Lecture Time: 1:25-2:15 PM, Mondays and Wednesdays

Lab Location: Seitz 109 or 115B

Lab Time: 11:15 – 1:15 or 1:25 – 3:25, Fridays

Instructor: Warren C. Ruder, Ph.D.

Office: 301K HABB1

Phone: 540-231-0035

E-mail: wruder@vt.edu

Teaching Assistants: TA1, Weihua Guo, gweihua2@vt.edu

TA2, JaeEung Kim, jaeekim@vt.edu

TA3, Jordan Wetzig, jordanw@vt.edu

Office Hours: Dr. Ruder: M, 9-12, HABB1 301K

TA1: Weihua Guo, W, 2:30 -5:30 pm, HABB1 Room 302G

TA2: JaeEung Kim, T, 8 - 9:30 & 4:45 - 6:15, HABB1 Room 301G

TA3: Jordan Wetzig, TR, 1:00 - 2:30, HABB1 Room 301G

Course Description:

Introduction to instrumentation and sensors for measurement and control of biological systems. Sensor response dynamics, data acquisition, sensor selection, signal processing and signal conditioning principles. Experimental determination of velocity, pressure, strain, displacement, forces and chemical constituents. Data analysis focused on uncertainty, error and statistical concepts. Pre: ESM 3024 (2H, 2L, 3C).

Learning Objectives:

Upon successful completion of the course, students will be able to:

- Select sensors for monitoring and controlling biological systems.
- Measure biological processes using thermocouples, thermistors, pressure transducers, flow meters, photo diodes and strain gauges; chromatography, electrophoresis and spectroscopy.
- Perform computer based data acquisition and data processing.
- Determine relevant statistical parameters and estimate uncertainty in the biological system measured.

Textbook (Required):

Instrumentation and Control Systems

by William Bolton, 2012. ISBN-13: 978-0081006139

ISBN-10: 0081006136

Course Website:

Check the course website (Canvas or http://canvas.vt.edu) regularly for course materials, assignments, and announcements.

Course Topics:

This course will complement other coursework in biological systems by covering these topics: *Instrumentation fundamentals and electrical theory review, an overview of biosensors, types of sensors and applications (i.e., temperature, force, pressure and flow), sensor selection and specification sheets, data acquisition, signal processing and analysis, signal conditioning, statistics in instrumentation and experimental design, uncertainty analysis, process control, and chemical measurements (i.e., chromatography, spectrophotometry)*

Tentative course schedule (subject to change at instructor's discretion):

Week 1: Introduction/Electronics Concepts Ch. 1

Week 2: Thermal Measurement and the Thermistor Ch. 1

Week 3: Thermal Measurement and the Thermocouple Ch. 2

HW 1 is due.

Week 4: Pressure Measurement and Pressure Transducer 1 Ch. 2/3

LR 1 is due.

Week 5: Pressure Measurement and Pressure Transducer 2 Ch. 2/3

HW 2 is due.

Week 6: Flow Measurement and Flow Meter 1 Ch. 2/3

LR 2 is due.

Week 7: Flow Measurement and Flow Meter 2 Ch. 2/3

HW 3 is due.

Week 8: Instrumentation Case Studies Fall Break Oct. 14 – No Lab Ch. 3

LR 3 is due.

Week 9: Integrated Pressure and Flow Ch. 3

HW 3 is due.

Week 10: Measuring Strain and Weight Ch. 2/3

Midterm Exam Oct. 24

LR 3 is due.

Week 11: Intro to Control, Electrophoresis and Chromatography Ch. 4

HW 4 is due.

Week 12: Control, Light Based Sensors Ch. 4

Nov. 9 will be a Video-in-Place-of-Class Lecture

LR 4 is due.

Week 13: Control, Spectroscopy Ch. 4/5

HW 5 is due.

Week 14: Thanksgiving Break (No class)

LR 5 is due.

Week 15: Control, Op-Amps, and Thermocouple 2 Ch. 5

HW 6 is due.

Week 16: Exam Review and Final Exam Ch. 1-5

LR 6 is due.

Final Exam, Friday December 9, 1:05-3:05 pm

Course Structure:

This course covers instrumentation theory and practical applications. In order to link the lectures to the practical training in the laboratory, the course structure typically will be as follows:

Monday: Instrumentation Theory (e.g., defining a system, signal conditioning, signal processing, control theory concepts)

Wednesday: Practical Applications of Instrumentation Theory to the Upcoming Laboratory (e.g., how the sensor in the Friday lab works, why and where it is used, etc.). The instructor will review practical concepts and demonstrate the laboratory setup (e.g., wiring connections, use of sensors, etc.). This will often be in the form of a video lecture posted on Canvas. Prior to the lab session, a pre-lab quiz (counted as part of the "Laboratory Reports" grade) will be completed by students online.

Friday: Laboratory Exercises in the lab with assistance from the TAs.

Course Grade:

Grading Scale:

Letter Grade	
A	93 - 100.00
A-	90 - 92.99
B+	87 - 89.99
B	83 - 86.99
B-	80 - 82.99
C+	77 - 79.99
C	73 - 76.99

C-	70 - 72.99
D+	67 - 69.99
D	63 - 66.99
D-	60 - 62.99
F	0 - 59.99

Graded Component Percentages:

Laboratory Reports	25%
Homework Assignments	25%
Midterm Exam (October 24 in class)	25%
Final Exam (December 9, 1:05-3:05 PM)	25%

Laboratory Reports and Assignments:

There will be either a laboratory report, or an assignment, due each week (but not both). There will be approximately 6 of each. These due dates will alternate. Laboratory reports will cover multiple laboratory sessions. Homework assignments will cover the concepts from multiple weeks. Grading rubrics for each laboratory report will be provided with the laboratory report assignment. The assignments will focus more on the theoretical components and the laboratory assignments on the practical assignments, as well as provide practice in technical communication.

Late Policy:

No late work will be accepted unless you have your absence verified (see below), or you make arrangements previous to the due date or the exam date.

Special Needs:

If you need adaptations or accommodations because of a disability, please provide the instructor with proper documentation from the Services for Students with Disabilities (SSD) office at the beginning of the semester so that proper arrangements can be made. Testing for students with disabilities will be conducted by SSD. Alternative times and locations will be decided upon prior to the exams in conjunction with SSD.

Procedure for Verified Absences:

If for some reason you miss an assignment or an exam and would like to make it up, the instructor will not decide whether or not your reason is acceptable. Instead, the instructor with work with students having a verified absence and develop alternate arrangements for making up the assignment or exam. Students are not to share personal information with the instructor as a means to arbitrate an absence. Mechanisms exist within the university to verify absences without compromising student personal information. Students should have their absences verified by the Dean of Students Office or the Schiffert Health center. The verification of absence is sent by one of these offices to the student's academic dean's office. The academic dean's office then forwards the verification of absence to the student's professors. Thus, student personal information is retained at the university/college level.

Procedure for Absence due to Student Travel:

If you will be traveling and know you will miss an assignment, exam, (or other graded work), please submit the assignment using the features on the Canvas website. If you will miss the midterm exam, please speak directly to the instructor to make alternate arrangements.

Honor Code:

The Undergraduate Honor Code pledge that each member of the university community agrees to abide by states:

"As a Hokie, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do."

Students enrolled in this course are responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any assignment is responsible for obtaining specific guidance from the course instructor before submitting the assignment for evaluation. Ignorance of the rules does not exclude any member of the University community from the requirements and expectations of the Honor Code.

For additional information about the Honor Code, please visit:

http://www.honorsystem.vt.edu/

Honor Code Pledge for Assignments:

The Virginia Tech honor pledge for assignments is as follows: "I have neither given nor received unauthorized assistance on this assignment."

The pledge is to be written out on all graded assignments at the university and signed by the student. The honor pledge represents both an expression of the student's support of the honor code and an unambiguous acknowledgment that the student has, on the assignment in question, abided by the obligation that the Honor Code entails. In the absence of a written honor pledge, the Honor Code still applies to an assignment.

All assignments submitted shall be considered "graded work" and all aspects of your coursework are covered by the Honor Code. All projects and homework assignments are to be completed individually unless otherwise specified.

Commission of any of the following acts shall constitute academic misconduct. This listing is not, however, exclusive of other acts that may reasonably be said to constitute academic misconduct. Clarification is provided for each definition with some examples of prohibited behaviors in the Undergraduate Honor Code Manual located at http://www.honorsystem.vt.edu/

CHEATING

Cheating includes the intentional use of unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise, or attempts thereof.

PLAGIARISM

Plagiarism includes the copying of the language, structure, programming, computer code, ideas, and/or thoughts of another and passing off the same as one's own original work, or attempts thereof.

FALSIFICATION

Falsification includes the statement of any untruth, either verbally or in writing, with respect to any element of one's academic work, or attempts thereof.

FABRICATION

Fabrication includes making up data and results, and recording or reporting them, or submitting fabricated documents, or attempts thereof.

MULTIPLE SUBMISSION

Multiple submission involves the submission for credit—without authorization of the instructor receiving the work—of substantial portions of any work (including oral reports) previously submitted for credit at any academic institution, or attempts thereof.

COMPLICITY

Complicity includes intentionally helping another to engage in an act of academic misconduct, or attempts thereof.

VIOLATION OF UNIVERSITY, COLLEGE, DEPARTMENTAL, PROGRAM, COURSE, OR FACULTY RULES

The violation of any University, College, Departmental, Program, Course, or Faculty Rules relating to academic matters that may lead to an unfair academic advantage by the student violating the rule(s).