University of Nebraska-Lincoln
Department of Biological Systems Engineering
MYSM 416/816: Sensors and Control Systems for Agri-Industries
Fall 2021

Instructor:
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By appointment

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Catalog Description:

MYSM 416 - Sensors and Controls for Agri-Industries Prereq: MYSM 245 or permission. This course deals with the basics of electrical and electronic components, sensors, and application of sensors for measurement of process control variables. Micro-computer based measurement, software application development, and sensor based actuator control will form a significant portion of the class.

- **Overarching Learning Goals:**
  1. Describe and interpret basic laws of electrical circuits
  2. Comprehend the working principles of different types of sensors and demonstrate their applications
  3. Create sensor data acquisition applications using programmable Arduino hardware
  4. Design sensor data acquisition and actuator control schemes for agricultural production settings and industrial food processing

- **Topic-Related Learning Goals:**
  1. Describe and interpret basic laws of electrical circuits
     - Apply Ohm's Law, Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) for interpreting and solving simple electrical circuits
     - Distinguish between series and parallel electrical circuits and estimate the voltage and current values at specified locations in the circuit
     - Design voltage divider circuits for obtaining desired voltages required by an application
     - Demonstrate the principles of voltage divider circuits in using rotary and linear potentiometers for position measurement applications.
  2. Comprehend the working principles of different types of sensors and demonstrate their applications
     - Understand the working principles of resistive, light and ultrasonic based sensors
     - Calibrate sensors to generate calibration equations and evaluate the relationship between the physical quantity measured and the sensor's electrical signal
     - Identify the applications of sensors based on their working principles and characteristics for agricultural production settings and specify the limitations of the sensors

3. Create sensor data acquisition applications using Arduino programming
    - Describe the process of A/D conversion and distinguish between analog and digital sensor signals
    - Illustrate the differences between data acquisition modules based on A/D converter resolution
    - Interface sensors with Arduino PCBs
    - Create Arduino sketches for performing A/D conversion and display of data in engineering units
    - Design and create standalone data acquisition modules using Arduino based controller module kits
4. Design actuator control schemes for agricultural production settings and industrial food processing
    - Demonstrate actuator control by using sensor feedback to control motors and linear actuators
    - Demonstrate techniques to vary the speed of the actuators (motors and linear actuators)

References and Resources:

- Lecture slides and laboratory exercises.
- Scherz, Paul and Simon Monk. 2013. Practical Electronics for Inventors – 3rd edition. New York, NY. Mc-Graw Hill.
- Arduino resource available at: https://www.arduino.cc/

Course Schedule:

Lectures: MW 9:00 am to 9:50 am, Splinters Lab 102
Labs: Friday's 8:00 to 9:50 am (Sec-I); 10:00 – 11:50 (Sec – II), Splinters Lab 102

COVID-19 Face Covering Policy:

An individual in this course has a documented need for face coverings to be required in this course. Without divulging personal or identifying information, such a documented need might be that a member of their household is unable to be vaccinated or has a health condition that makes vaccines less effective for them. As a result, the College of Agricultural Sciences and Natural Resources has determined that face coverings will be required in this course. If you are unwilling to comply with this requirement, please visit with your advisor about different sections or possible alternative courses that you might take in lieu of this one.

Grading System:

Component of Work	Undergraduate Students Contribution to Semester Average	Graduate Students Contribution to Semester Average
Class Participation	10%	10%
Homework	25%	10%
Labs	15%	15%
Exams/Projects	50%	50%
Technical Article	N/A	15%

The semester average will be determined as a composite of your class participation, homework, laboratories and exams/projects. The portion each contributes to the semester average is shown in the table above. The grade assigned will be based on the semester average as shown in the table below. The instructor reserves the right to adjust the scale. Borderline grades will be decided based

on the completion of homework and class participation. Students seeking graduate credit are required to do a course project which corresponds to 50% of the grade. Additionally the graduate students are required to develop a technical manuscript in a journal publication format.

Semester Average	Grade	Semester Average	Grade	Semester Average	Grade
96.7-100%	A+	83.3-86.7%	B	70.0-73.3%	C-
93.3-96.7%	A	80.0-83.3%	B-	66.7-70.0%	D+
90.0-93.3%	A-	76.7-80.0%	C+	63.3-66.7%	D
86.7-90.0%	B+	73.3-76.7%	C	60.0-63.3%	D-
				0-60.0%	F

Pass/No Pass Option – Students enrolled under this option must achieve at least the percentage required for a C letter grade to receive a passing grade (P). See SCHEDULE OF CLASSES. University policy regarding marks of I (incomplete) and W (withdraw) will be followed in this course. See SCHEDULE OF CLASSES.

Homework:
Homework must be done in an A4 size paper in a neat and logical format including a summary of the problem statement, given data, statement of assumptions, equations and work to solve the problem. Units must be shown at all times. Sources for equations and any values from tables used in the solution must be documented so anyone reviewing the problem solution can locate the original equation or data quickly. Assignments will be made weekly and will be due at the beginning of class. Assignments not submitted on time will be worth ½ credit if submitted within one week of the scheduled time. Collaboration on homework is permitted and encouraged however, the students should present their own work.

Exams and Projects:
Two exams and a course project are tentatively planned. A minimum of one week notice will be provided of the exact dates. Makeup exams may be arranged at the discretion of the instructor if arrangements are made in advance.

Attendance Policy:
Changes to the class schedule or assignments will be announced in class or through CANVAS. Each student is responsible for everything discussed in class. Attendance will not normally be taken; however, excessive absences will adversely affect the class participation portion of your grade.

Academic Dishonesty:
Students are expected to adhere to guidelines concerning academic dishonesty outlined in Section 4.2 of the University's Student Code of Conduct (http://stuafs.unl.edu/ja/code/). The BSE Department process for grade and academic dishonesty appeals can be found at http://bse.unl.edu/academicadvising-index Students are encouraged to contact the instructor for clarification of these guidelines if they have questions or concerns.

Topic Outline (Tentative Course Schedule - Subject to Change):

Week	Topic
Week 1	Introduction to Sensors and Controls
	Basics of Circuits
	No Lab
Week 2	Basics of Circuits
	Voltage Divider Circuits
	Lab 1
Week 3	Potentiometers
	Analog and Digital Signals
	Lab 2
Week 4	Sensors
	Arduino Basics
	Lab 3
Week 5	Arduino Programming Basics
	Arduino Programming Basics
	Exam-I
Week 6	Arduino -A/D and Digital inputs
	Arduino- Arrays- A/D and Digital inputs
	Lab 4
Week 7	Arduino - Sensor Interfacing
	Arduino - Sensor Interfacing
	Lab 5
Week 8	Arduino - Digital Outputs
	Arduino - Digital Outputs
	Lab 6
Week 9	Arduino - PWM
	Arduino - PWM
	Lab 7
Week 10	Arduino Project Assign
	Arduino Project Assign
	Exam - II
Week 11	Project Updates & Discussion
	Project Updates & Discussion
	Lab 8
Week 12	Project Updates & Discussion
	Project Updates & Discussion
	Lab 9
Week 13	Project Updates & Discussion
	Project Updates & Discussion
	Lab 10
Week 14	**Project Presentations**
Week 15	**Finals Week (Project Reports Due)**

- **Fire Alarm (or other evacuation):** In the event of a fire alarm: Gather belongings (Purse, keys, cellphone, N-Card, etc.) and use the nearest exit to leave the building. Do not use the elevators. After exiting notify emergency personnel of the location of persons unable to exit the building. Do not return to building unless told to do so by emergency personnel.
- **Tornado Warning:** When sirens sound, move to the lowest interior area of building or designated shelter**.** Stay away from windows and stay near an inside wall when possible.
- **Active Shooter**
    - **Evacuate:** if there is a safe escape path, leave belongings behind, keep hands visible and follow police officer instructions.
    - **Hide out:** If evacuation is impossible secure yourself in your space by turning out lights, closing blinds and barricading doors if possible.
    - **Take action**: As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.
- **UNL Alert:** Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information go to: http://unlalert.unl.edu.

Students with Special Needs

- Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.

Links for COVID-19 Information & Resources

- https://covid19.unl.edu/guiding-framework
- https://covid19.unl.edu/face-covering-policy