Instrumentation in Agriculture Engineering Research
ABE 6031 Section IAGR Number 21510
Class Periods: T & Th, 7th and 8th period, at 1:55PM to 3:50 PM
Location: 211 Rogers Hall and 214 Rogers Hall
Academic Term: Fall 2025

Instructor:
Tom Burks
Email Address: tburks@ufl.edu
Office Phone Number: 352-294-6728
Office Hours: T or Th, 1:00PM to 1:30PM, 225 Rogers Hall

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
Please contact through the Canvas website
- Dr. Zafar Iqbal
- Email: iqbal.m@ufl.edu

Course Description: 3 Credits
Principles and application of measuring instruments and devices for obtaining experimental data in agricultural engineering research.

Course Pre-Requisites / Co-Requisites:
Students must have taken an undergraduate Differential Equations class, and will benefit from have taken an undergraduate engineering or physics based electrical circuits class. Familiarity with Matlab, Python, C, C++ or other programming experience would also be beneficial.

Course Objectives
Student will study fundamental aspects of instrumentation and data acquisition applicable for Agricultural and Biological systems, such as, zero, first and second order systems characterization, uncertainty analysis, error sources and propagation, probability and statistics in data collection, data acquisition, analog and digital circuits, along with various typical sensors used in Ag & Bio Eng. They will also gain practical hands-on experience as they build electrical circuits, and learn to program and build data acquisition systems for various applications using Labview and Ardunio based devices, which will give them a breadth of exposure to various sensors, sensor networks, data management, and analysis tools. Students will also learn to use National Instrument's MultiSim to build, test and evaluate common circuits and devices such as; passive and active filters, operational amplifier circuits and other.

Materials and Supply Fees
$40 per student

Required Textbooks and Software
- *Theory and Design for Mechanical Measurements*, 7th ed
- Author: Figliola and D.E. Beasley
- Publication: John Wiley and Sons,Inc
- ISBN: 978-1119723455

Recommended Materials (Provided as desk reference in Lab)
- Title: *Introduction to MultiSim*, 11th ed.
- Author: Nilsson and Riedel
- Publication: Pearson Education, Inc.
- ISBN: 978-0134739342

Recommended Materials (Provided as desk reference in Lab)

- Title: *Hands-On Introduction to LabVIEW*, 4th ed
- Author: John Essick
- Publication: Oxford University Press.
- ISBN: 978-0190853068

Recommended Materials (Available through e-book)

- Title: Beginning Sensor Networks with XBee, Raspberry PI, and Arduino, 2nd ed.
- Author: Charles Bell
- Publication: Springer Nature.
- ISBN: 978-1484257951

Recommended Materials (Selected chapter PDF available in class folder)

- Title: *Instrumentation and Measurement for Environmental Sciences,*
- Author: Z.A.Henry,
- Publication: American Society of Agricultural and Bilogical Engineers
- ISBN: 0929355164 (Out of print, limited availability used at AddAll.com for under $10)

Course Meeting, Structure, and Objectives:

Lecture Period: Tuesday 8th and 9th period in room 211 Rogers Hall

The lecture period will be used to develop a basic theoretical understanding of key issues in experimental/instrumentation design, signal conditioning, analog devices, data acquisition and sampling, and fundamental sensor applications. Some days lecture may take longer or shorter than a full class period, and transition to lab will be accordingly. Once lecture time is completed, the remainder of the 2nd period of class will be used on laboratory related topics.

Lab Period: Thursday 8th and 9th period in room 214 Rogers Hall

The lab will be used to provide hands on experience with instrumentation equipment such as oscilloscopes, function generator, data acquisition boards, bread boarding circuits, and other practical techniques. Demonstration and assignment labs will be provided and required, respectively. Additionally, the laboratory will be used to introduce the student to Arduino/Raspberry PI and LabVIEW applications in instrumentation. This semester it is planned to add a new section on using Nvidia Jetson running ROS as a data acquisition tool. The student will be given moderate guidance with ample opportunity to explore and learn at one's own initiative.

1) There will be approximately one homework and one lab assignment per week. You may discuss homework with others, but you may not copy verbatim homework from another student. Cheating on homework <u>will affect all parties</u> involved.
2) Some laboratories will require preparation, others are primarily demonstrations. <u>It is mandatory to attend Labs.</u> Get advance approval if you can't attend lab. Some labs will require a report by team members. There are five major laboratory sections that will be scheduled throughout semester and will have reporting requirements.

- Benchtop devices and circuit building (Burks)
- Embedded device sensor nodes using Arduino (Iqbal)
- Multisim circuit simulations (Burks)
- Labview programming, data acquisition and systems modeling (Burks)
- Raspberry PI Embedded Systems and sensor networks (Iqbal)

3) Each student will make a 10 minute technical presentation and turn in a minimum 3 to 5 page typed summary report covering a topic in instrumentation and sensor technology not covered in the text. The presentation must be thorough and technically accurate. The student should select a topic based on his/her personal research interest.

4) Each student will complete a term instrumentation project using LabView. The project will incorporate data acquisition design, programming, data collection, and basic data analysis. A project report will be required.
5) Students will work in a team to build a Raspberry PI with Arduino based sensor network for a practical application to collect data, send data through network to the cloud, and analyze data for report.
6) At the end of semester, the student will turn in a PDF collection of ½ -1 page abstracts from each of the required readings chapters from IMES which describes the content and contributions of each chapter. The PDF of chapter text is in the class OneDrive folder.

Recommended Readings from Instrumentation and Measurements for Environmental Sciences to compliment textbook material;

Item	Reading	Associated Textbook Chapter
1	IMES-1: Planning the Experiments	ASAP
2	IMES-11: Systems Response	Chapter 3
3	IMES- 14: Indicating and Recording	Chapter 6
4	IMES-15: Analysis and Interpretation	Chapter 4
5	IMES- 10: Signal Conditioning	Chapter 6
6	IMES- 13: Digital Data Acquisition	Chapter 7
7	IMES- 16: Interfacing Microcomputers for Data Acquisition and Control	Chapter 7

Lecture Material Covered:
There will be an approximate 1h and 15m lecture during the Tuesday meeting time from the primary textbook (MM). At the end of each textbook lecture, class time will be spent doing a review of basic circuits as applies to this class. As the semester progresses the remaining time will be spent on Arduino experiments, MultiSim applications and usage from MultiSim text, and LabVIEW programming concepts from LabVIEW text.

Week 1. Welcome to Class; Intro to Arduino Kits
Week 2. MM-1: Basic Concepts of Measurement Systems; Basic Circuits Review
Week 3. MM-2: Static and Dynamic Characteristics of Signals
Week 4. MM-3: Measurement Systems Behavior; Micro-Python
Week 5. MM-4: Probability and Statistics; Circuits Network and Building
Week 6. MM-5: Uncertainty Analysis; RLC Circuits; Intro to RP4 Sensor nodes
Week 7. MM-6 Analog Electrical Devices
Week 8. MM-7: Sampling, Digital Devices, and Data Acquisition: Intro Sensor Networks
Week 9. MM-8: Temperature Measurements
Week 10. MM-9: Pressure and Velocity
Week 11. MM-10: Flow Measurement: RP4 with XBEE sensor networks
Week 12. MM-11: Strain Measurement
Week 13. LabView and Raspberry PI-4 Sensor Network
Week 14. LabView and Raspberry PI-4 Sensor Network
Week 15. Thanksgiving Week Holiday
Week 16. LabView and Raspberry PI-4 Sensor Network

Laboratory Topics Covered:
The laboratory time will consist of both instructor lead demonstrations and teaching, and hands on laboratory experiments. In many cases, laboratory experiments will be introduced and started during the in-class laboratory

time to be finished later by the student with lab partners. A brief lab reported will be submitted by the teams on each lab experiment assignment.

Week 1: Introduction to Arduino self-paced exercise assignments
Week 2: Introduction AC & DC benchtop instruments; Intro to Arduino Programming
Week 3: Introduction to Multisim Circuit Simulation using passive Analog Devices
Week 4: Introduction to Multisim Circuit Simulation: Intro to micro-python programming
Week 5. Intro to building Analog Electrical Devices-Passive and Active
Week 6. Introduction to LabVIEW, and While Loop and Waveform Chart; Intro RP4 nodes
Week 7. LabVIEW For Loop and Waveform Graph, Arrays and Clusters
Week 8. LabVIEW Mathscript Node and XY Graph: Building Passive/Active Circuits
Week 9. LabView Data Files and Character Strings
Week 10. LabVIEW Data Acquisition using MAX, and DAQ Assistant
Week 11. LabVIEW Shift Registers and Case Structures: RP4 and XBEE Sensor Networks
Week 12. LabVIEW Data Acquisition, and Signal Processing: Curve Fitting
Week 13. LabVIEW Data Acquisition, and Signal Processing: Fast Fourier Transform
Week 14. LabView and Raspberry PI-4 Sensor Network
Week 15. Thanksgiving Week Holiday
Week 16. LabView and Raspberry PI-4 Sensor Network

Attendance Policy, Class Expectations, and Make-Up Policy

a) Homework assignments from the textbook are due on the assigned date, no late homework accepted. Lab and programming assignments are flexible, with up to two weeks grace period. Your lowest homework assignment will be dropped.
b) Attendance is mandatory, unless excuse is valid. Absence will affect you and lab partner's ability to do projects, so it is necessary to attend.
c) Excused absences must be consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

Grading Criteria:

Textbook Homework	20%
Arduino/Raspberry PI Circuit Experiments	10%
Embedded Sensor Network Experiment	10%
Technical Presentation	10%
Circuit building lab experiments	10%
Labview Exercises and Problems	10%
Labview Project	10%
Multisim Circuit Simulation	10%
Take home final exam	10%
Reading Summaries (Extra Credit)	10%
Total	**100% + 10%**

Grading Policy
The following is given as an example only.

Percent	Grade	Grade Points
95 - 100.0	A	4.00
90-94.9	A-	3.67
87.0 - 89.9	B+	3.33
84.0 – 86.9	B	3.00
80.0 - 83.9	B-	2.67
77.0 - 79.9	C+	2.33
74.0 – 76.9	C	2.00
70.0 - 73.9	C-	1.67
67.0 - 69.9	D+	1.33
64.0 - 66.9	D	1.00
60.0 - 63.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades

Students Requiring Accommodations
Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment
The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
• Your academic advisor or Graduate Program Coordinator
• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall*,* 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.