ETEE 4369 01 Instrumentation and Interfacing (3 cr. Hrs, 4-contact Hrs.)
TTh: 1:00 – 2:50 PM PETC 220

Instructor: Dr. Reg Pecen, Quanta Endowed Professor
Office: PETC 420D @ 936-294-4137 e-mail: regpecen@shsu.edu
Office Hours: TTh: 11:00-11:50 AM and 3:00 – 5:00 PM
(*You can also call or e-mail me and arrange extra office hours by appointment*).

Textbook: *Instrumentation and Process Control, 6th Ed. by F. W. Kirk, T.A. Weedon, P. Kirk, American Technical Publishers, Inc. 2014.*
NI LabVIEW™ Student Support at ni.com/mydaq

Workbook: Instrumentation and Process Control, 6th Ed. By T. A. Weedon, *American Technical Publishers, Inc. 2014.*

Course Catalog Description: Students in this course learn about computer-aided instrumentation and interfacing, real-time industrial data acquisition hardware and software, sensors, signal conditioning, design and debugging of data acquisition using software tools. Pre-requisite: ETEE 3350 Solid State Electronics - 3 Credits.

Course Objectives: The knowledge and skills of the instrumentation and interfacing in the ECET areas have become significant in terms of involving in applications of sensors and transducers, and design of associated interface circuits; laboratory experience integrating sensors, and data acquisition hardware and software; and experiment-design project implementation and reporting experience using both actual lab equipment and virtual instruments. National Instrument (NI)'s LabVIEW™ is used to create virtual instruments and to facilitate data acquisition.

This course serves as a core class for both degree programs and it is one of the essential components for the employability of students, especially in electronics and computer engineering technology fields, and is an essential part of electronics, computer engineering technology, and electrical engineering technology program curricula. Students graduating from these programs will be involved in programming, troubleshooting, control, interfacing, instrumentation in industrial operations and dealing with applications during their careers as part of their main job duties.

Upon completion of this course, students should be able to gain following competencies:

1. Discuss concepts and elements of a measurement and instrumentation system;
2. Examine sensors, analog and digital signal conditioning methods used in instrumentation systems;
3. Explain the applications of sensors, analog and digital signal conditioning methods used in instrumentation systems;
4. Apply computer based controls and virtual instrumentation software using LabVIEW™ and other programs, and;
5. Use data acquisition hardware and software to design systems which read and write digital and analog information
6. Understand the principles of data acquisition and sampling
7. To be able to design with and analyze circuitry for common sensors and/or actuators

8. Write virtual instruments in LabVIEW™ for measurement and control
9. Identify the common elements to PC based control and measurement systems

Course Learning Outcomes and Assessment:

The ability to conduct and design experiments is rated as one of the most desirable technical skills of engineering and engineering technology graduates. Specifically, the referenced survey indicates that employers want graduates with a working knowledge of data acquisition, analysis and interpretation, and an ability to formulate a range of alternative problem solutions. Additionally, many employers of our EET graduates are in the manufacturing and testing sector of the industry providing additional motivation for a hands-on instrumentation and data acquisition course.

The three major objectives of this course are: (1) understanding the principles and applications of sensors and transducers, and the design of associated interface circuits; (2) providing laboratory experience in integrating sensors, interface electronics, and data acquisition hardware and software; and (3) providing hands-on instrumentation project design, implementation, and reporting experience.

The mapping between these three course objectives and student outcomes as defined by the Criteron-3 of ABET-ETAC is shown in Table I. Definitions of specific ABET-ETAC student outcomes applicable to this course are listed below for the sake of completeness.

- Outcome a: Ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities,
- Outcome b: Ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies,
- Outcome c: Ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes,
- Outcome d: Ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives,
- Outcome e: Ability to function effectively as a member or leader on a technical team,
- Outcome f: Ability to identify, analyze, and solve broadly-defined engineering technology problems,
- Outcome g: Ability to apply written, oral, and graphical communication in both technical and nontechnical environments; and an ability to identify and use appropriate technical literature,
- Outcome h: Understanding of the need for and an ability to engage in self-directed continuing professional development,
- Outcome i: Understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity, and
- Outcome k: Commitment to quality, timeliness, and continuous improvement.

Table I: Mapping of Course Objectives to Student Outcomes

Course Objectives	Supported Student Outcomes (per ABET-ETAC Criterion-3)

Principles and applications of sensors and transducers, and associated interface circuit design	a,b,d
Laboratory experience integrating sensors, interface electronics, and data acquisition hardware and software	a, b, c, d, e, f, g, h, i, k
Hands-on instrumentation project design, implementation, and reporting	a, b, c, d, e, f, g, h, i, k

This is a new course in the SHSU ECET major and the students will be assessed for the course objectives and associated outcomes using various direct and indirect assessment tools. Additionally, course-embedded direct assessment of objectives and university-level end-of-semester faculty and course indirect assessment provide valuable input to the overall course assessment and continuous improvement process. The results from various direct and indirect assessment instruments are archived and processed annually to generate action items used as input to the course's continuous improvement process.

Computer Software Tool: NI's LabVIEW™ software, and NI *myDAQ Data Acquisition Kit* that comes with related components and application software will be used. ***ni.com/mydaq***

Class Structure and Attendance: This is an important ECET major class and your attendance is highly encouraged. Lectures, laboratory experimental projects, homework assignments, and quizzes will constitute the structure of the course. The make-up labs and exams will be given only in the case of **documented physical illness** (**In this case, students must inform instructor at least 24 hours before the exam**). *There will be no make-up option if you are not in the class during the pop-quiz time.*

We are tentatively planning to devote the first three weeks of classes on NI LabVIEW™ Programming. After that, the concepts and integration of sensor, transducers, interface electronics, and data acquisition and instrument control hardware/software are covered. The last week of the semester is dedicated to student design project presentations that will integrate student knowledge in instrumentation hardware and software via developing a project of choice.

Typical course content is tentatively planned as follows:

- Fundamentals of programming logic: Virtual instruments, indicators/controls; front panel/block diagram; data types and data flow programming; structures, clusters, arrays, and loops; graphs and charts; subVIs; and file I/O.
- Sensors and transducers: Resistive, capacitive, and inductive sensors; temperature sensors; position, displacement, and speed sensors; force and pressure sensors; vibration and acceleration sensors; proximity and presence sensors; electro-optical sensors; flow and flow-rate sensors; and liquid-level and humidity sensors.
- Signal conditioning and data acquisition: Analog-to-digital and digital-to-analog converters; sampling rate, multiplexing, resolution, range, and code width; grounding, isolation and noise; single-ended and differential measurements; attenuation, amplification, and filtering; excitation and linearization; impedance mismatch and loading; signal transmission (voltage vs. current loop); and hardware architecture of a modern multi-function data acquisition device.
- Instrument control: Components of an instrument control system (GPIB and RS-232); detecting and configuring instruments; and instrument drivers.

- Instrumentation system design: Design specifications; functional block representation; design, debugging, and testing; interpretation and presentation of data; user interface; temperature control system design; motor speed control system design; and student initiated experiment-design projects integrating sensors/transducers, actuators, interface electronics, and data-acquisition hardware and software.

Homework & Lab Assignments: Homework assignments will be collected and graded regularly. No credit will be given for late homework assignments (except documented physical illness). Students are encouraged to work and discuss with others on the lab reports and homework assignments, however, submissions must consist of the students own work, in accordance with departmental policies. Please work neatly, showing all calculations, manipulations, plots and program files (if any) required reaching your solution.

- Students are encouraged to work and discuss with others on the lab reports and homework assignments, however, submissions must consist of the students own work, in accordance with departmental policies. Please work neatly, showing all calculations, manipulations, plots, and simulation program files (if any) required reaching your solution.

Simulation /Design Project: All students are expected to complete a class project based on their choice of interest in in the data acquisition, instrumentation, and interfacing using the components available in the ECET laboratory. The project will involve a proposed solution with a demonstration of specific aspects of the process of the circuit. The last one week of the semester is dedicated to student-initiated experiment-design projects carried out in a group of two or three students. This is an opportunity for students to integrate the software and hardware knowledge they have gained during the first twelve weeks of the semester, and use their creativity to develop an experiment-design project in a friendly yet competitive environment. Each group of students is required to submit a proposal with experiment-design project idea. The proposal should include project implementation steps, I/O interface drawing, circuit schematics, parts list with vendor/price information to make sure the parts are available in the lab, LabVIEW program flow chart, and project completion schedule. Students are responsible for selecting the necessary sensors, transducers, and actuators. Students must inform the instructor in advance for the order of missing project-specific parts in the laboratory. A formal presentation and a final report are due at the end of the semester.

You must submit a proposal of the project *by* ***Tuesday, October 31, 2017****. All projects must be approved by Tuesday, November 7, 2017.*

- You will be expected to present and submit your project reports in the class on the last week of the semester **(November 28-30, 2017).** All the project reports should include the purpose of the project, technical details, schematic diagrams, simulation - practical design measurements, results, and conclusion.

Classroom Rules of Conduct: Students will avoid doing behavior in the classroom that intentionally or unintentionally disrupts the learning process and, thus, obstructs the mission of the university. Cellular telephones and pagers must be turned off before class begins. The use of cell phones or other electronic devices is prohibited without permission of the instructor. Students are prohibited from eating in class, using tobacco products,

making offensive remarks, reading newspapers, sleeping, talking at inappropriate times, or engaging in any other form of distraction. Inappropriate behavior in the classroom shall result in a directive to leave class. One warning will be given for a violation and all additional violations will result in a one letter grade reduction. If academic dishonesty is suspected, the student will be reported to the Dean of Students for disciplinary action in accordance with university policy.

Grading: The final grade will be based on the following requirements.

Mid-term Exam	**20%**
Final Exam	**20%**
Class DAQ Project	**15%**
Laboratory Experimental Projects (8 Lab Sessions)	**15%**
Homework Assignments (10 assignments)	**10%**
Attendance, Participation, Attitude	**10%**
Quizzes (Min 7)	**10%**
Total	**100%**

Percentage Range	Letter Grade
90 – 100	A
80 – 89	B
70 – 79	C
60– 69	D
0-59	F

Course Content and Lab Schedule: The tentative course content and lab schedule will include the following topics. Depending upon extra handouts/simulations/homework assignment explanations, ***the following tentative course content may be shifted slightly***.

		ETEE 4369 Instrumentation & Interfacing Fall 2017	
Week	**Date**	**Subject**	**Readings- Assignments- Resources**
1	8/24	Introduction to the course; Syllabus Review, Importance of Instrumentation, Interfacing, and Data Acquisition in today's and tomorrow's Industry LabVIEW™ Basics	Syllabus
2	8/29 – 8/31	LabVIEW™ Basics	Ni.com, LabVIEW™ Tutorials, ni.com/myDaq
3	9/5-9/7	LabVIEW™ Basics	Ni.com, LabVIEW™ Tutorials, ni.com/myDaq
4	9/12 - 9/14	**Chapters 1-2-3** Instrumentation Overview Fundamentals of Process Control	Textbook pp. 3-29

		Piping & Instrumentation Diagrams	
5	9/19 - 9/21	**Chapters 4-5-6** Temperature, Heat, and Energy Thermal expansion Thermometers Electrical Thermometers	Textbook pp 33-69 HW#1 TBA
6	9/26 - 9/28	**Chapters 7-8-9** Infrared Radiation Thermometers Practical Temp measurement and Calibration Pressure Measurement	Textbook pp 71-108 HW#2 TBA
7	10/3 – 10/5	**Chapters 10-11-12** *Mechanical Pressure Instruments* Electrical Pressure Instruments Practical Pressure Measurement and Calibration	Textbook pp 110-138 HW#3 TBA
8	10/10 – 10/12	***Mid-Term Test (Chapters 1-12)*** **Chapters 13 -14** Mechanical Level Instruments Electrical Level Instruments	**Midterm Test, Tuesday, October 9** Ch. 1-12, LabVIEW Basic, ni.com/myDaq Textbook: 141-164 *HW#4 TBA*
9	10/17 – 10/19	**Chapters 15-16-17** Ultrasonic, Radar, and Laser Level Instruments Nuclear Level Instruments and Weigh Systems Practical Level Measurement and Calibration *Skip Ch 18-19-20*	Textbook pp 165-185 HW#5 TBA
10	10/24 – 10/26	**Chapters 21-30-31-** Magnetic, Ultrasonic, and Mass Flowmeters Digital Numbering Systems and Codes Digital Communications Skip Ch 22-29	Textbook pp 217-223 321-342
11	10/31 – 11/2	**Chapters 32-33** Industrial Networks Wireless Systems *Skip Ch 34*	Textbook pp 343-371
12	11/7 – 11/9	**Chapters 35-36** Automatic Control and Process Dynamics Control Strategies	Textbook pp 383-429
13	11/14 – 11/16	LabVIEW™ Based Lab Projects	Handouts TBA
14	11/21 – **11/23**	LabVIEW™ Based Lab Projects	Handouts TBA
15	11/28 – 11/30	Class Project Implementation and Presentations	**Reports Due**
16	Dec. 4-8, Finals Week	**Final Exam; Thursday, December 7, 2017 @2:30 – 4:30 PM Chapters: All**	*Wishes best luck*

Laboratory Assignments: There are regular labs indicated on the class schedule. All laboratory project assignments must be completed for your lab grading. You must obey departmental laboratory safety rules & policies. ***You must attend and successfully complete the each lab.*** Lab reports due dates are provided in the tentative schedule. Make sure you write clearly and neatly! Please use the lab instruction handouts for your lab reports.
Note: *It is the student's responsibility to arrange make-up labs with the instructor. Make-up labs may be considered with a report proven medical reason.*

Rules and Recommendations for Effective and Safe Use of the Laboratory and Work Benches in PETC 210C Laboratory

1. ***DO NOT turn on the power before the instructor checks your circuit!***

2. Use the coat racks for neat laboratory appearance as well as safety. Do not place coats or book bags on workbenches.

3. Refrain from drinking beverages in the laboratory. The hall may be used for intervals of relaxation.

4. ***The lab bench must be cleaned and all wires must be returned to the hooks provided in the lab room before leaving the room.***

5. Report all component and equipment failures to your Instructor lab TA. Neglecting to report faulty equipment causes problems for the next group that uses the bench and may result in injuries.

6. When using the instruments ***DO NOT STACK THEM,*** as the combined heat may cause component failure.

7. Place all of the trainer units, transformers, motors, DMMs, resistors, inductors, capacitors, etc., back to their original places and/or *original rated* boxes after you are done with the laboratory.

8. ***All power switches should be turned off before leaving the lab bench.***

9. Rings and other jewelry, which may cause a potential hazard, must be removed before working in the laboratory.

10. No individual should operate equipment in the laboratory until the appropriate examinations are passed and/or demonstrations by instructor are safely observed.

I encourage you to utilize the Professional and Academic Center for Excellence (PACE)'s **free assistance with writing, math, science, reading, and learning strategies**. The PACE is dedicated to providing professional development for administration, faculty, staff, and students. Using programs and services founded on evidence-based teaching and leadership strategies, our ultimate goal is effective student learning and development. Please contact; CHSS Room C002 or e-mail: PACE@shsu.edu; Tel: 936-294-2688

General Safety Procedures – Introduced by the instructor	
I. Introduction: How Electricity Works a. Conductors b. Insulators c. Grounding	**II. Hazards of Electricity** a. Electrical shock b. Electrical burns c. Electrical fires d. Case Studies of Electrical Accidents
III. Types of Electrical Hazards a. Working on energized (hot) circuits b. Loose connections c. Frayed or missing insulation d. Missing ground prongs on plugs e. Water and electricity don't mix f. Damaged power tools g. Ungrounded equipment h. Improper use of extension cords	**IV. How to Protect Yourself from Electricity** a. General electrical safety rules b. Properly grounded electrical circuits c. Ground fault protection near water sources d. Insulated power tools e. Proper housekeeping f. Don't overload circuits
V. Soldering Hazards a. General soldering safety rules b. Proper handling of soldering equipment	

Academic Dishonesty: All students are expected to engage in all academic pursuits in a manner that is above reproach. Students are expected to maintain honesty and integrity in the academic experiences both in and out of the classroom. Any student found guilty of dishonesty in any phase of academic work will be subject to disciplinary action. The University and its official representatives may initiate disciplinary proceedings against a student accused of any form of academic dishonesty including but not limited to, cheating on an examination or other academic work which is to be submitted, plagiarism, collusion and the abuse of resource materials.

Student Absences on Religious Holy Days Policy: Section 51.911(b) of the Texas Education Code requires that an institution of higher education excuse a student from attending classes or other required activities, including examinations, for the observance of a religious holy day, including travel for that purpose. A student who is excused under this subsection may not be penalized for that absence and shall be allowed to take an examination or complete an assignment from which the student is excused within a reasonable time after the absence. University policy 861001 provides the procedures to be followed by the student and instructor. A student desiring to absent himself/herself from a scheduled class in order to observe (a) religious holy day(s) shall present to each instructor involved a written statement concerning the religious holy day(s). This request must be made in the first fifteen days of the semester or the first seven days of a summer session in which the absence(s) will occur. The instructor will complete a form notifying the student of a reasonable timeframe in which the missed assignments and/or examinations are to be completed.

Services for Students with Disability (SSD): The mission of the Services for Students with Disabilities (SSD) is **to promote full and equal access on the part of students** with disabilities to educational and extracurricular programs and activities at SHSU.It is the policy of Sam Houston State University that individuals otherwise qualified shall not be excluded, solely by reason of their disability, from participation in any academic program of the university. Further, they shall not be denied the benefits of these programs nor shall they be subjected to discrimination. Students with disabilities that might affect their academic performance should register with the Office of Services for Students with Disabilities located in the Lee Drain Annex (telephone 936-294-3512, TDD 936-294-3786, and e-mail disability@shsu.edu). They should then make arrangements with their individual instructors so that appropriate strategies can be considered and helpful procedures can be developed to ensure that participation and achievement opportunities are not impaired.

SHSU adheres to all applicable federal, state, and local laws, regulations, and guidelines with respect to providing reasonable accommodations for students with disabilities. If you have a disability that may affect adversely your work in this class, then I encourage you to register with the SHSU Services for Students with Disabilities and to talk with me about how I can best help you. All disclosures of disabilities will be kept strictly confidential. NOTE: No accommodation can be made until you register with the Services for Students with Disabilities. For a complete listing of the university policy, see: http://www.shsu.edu/dept/academic-affairs/documents/aps/students/811006.pdf

Tobacco Policy: In order to promote a healthy, safe, and aesthetically pleasing work, educational, and living environment, Sam Houston State University (SHSU) will endorse a smoke-free and tobacco-free environment. The primary purpose of this policy is to establish guidelines prohibiting smoking and the use of all tobacco products. Tobacco products include cigarettes, cigars, pipes, smokeless tobacco, and all other tobacco products. This policy applies to all faculty, staff, students, employees of contractors, and visitors of SHSU on the premises of the university.

Visitors in the Classroom: Only registered students may attend class. Exceptions can be made on a case-by-case basis by the professor. In all cases, visitors must not present a disruption to the class by their attendance. Students wishing to audit a class must apply to do so through the Registrar's Office.

"The schedule, policies, labs, and assignments in this course are subject to change in the event of extenuating circumstances or by mutual agreement between the instructor and the students."
Please do not hesitate to ask help from instructor.