ENGR 4421 / 001 – Instruments and Controls – Fall 2012

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Office Hours: 1:00-2:00 MWF, 2:00-3:00 TH, or by appointment

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Location: Q-315

Meeting times: MWF 10:00-10:50 am

Start Date: 08/15/2012

Pre-requisites: EE 2110 (Circuits), ENGR 3343 (Fluid Mechanics), and MATH 2306 (Differential Equations)

Textbook: Introduction to Engineering Experimentation, by Wheeler and Ganji, 3rd edition, Pearson.

Course Catalog Description: Characteristics of instruments used in mechanical systems for determining parameters such as temperature, pressure, and flow are studied. The use of these devices in automated systems is covered. Furthermore, the elements of control theory, selection of control modes, and application to mechanical systems are studied. Laboratory exercises illustrating the use of pertinent instrumentation for determining the performance of mechanical equipment are conducted.

Learning Outcomes:

1) Demonstrate proficiency in engineering data collection, data regression, compilation of results, and technical report writing.
2) Analyze the uncertainty in measurement systems using statistical and other analytical principles.
3) Demonstrate competence in programming for data acquisition using LabView software.
4) Identify, calibrate and use measurement instruments (pressure, temperature, and flow).
5) Evaluate different control methodologies, apply design principles for mechanical systems including pneumatics/hydraulics, and create industrial automation control solutions using Programmable Logic Controllers.

Topics Covered Include:

1) Measurement Systems
   a) Measurement Standards
      NIST, ISO, ANSI
   b) Generalized Measurement Systems
      Sensors, Signal Conditioning, Results, Sensor Performance (Static, Dynamic)
   c) Mechanical Measurements
      Temperature, Pressure, Mass / Force / Torque, Fluid Flow, Motion, Strain
2) Analyzing Measurements
   Statistical Analysis of Experimental Data, Uncertainty Analysis of Measurements
3) Measurements with Computerized Data Acquisition Systems (LabVIEW)
4) Design for Industrial Automation
   a) Instrumentation & Control System Documentation
      Process Flow Diagrams, Piping & Instrumentation Diagrams, Instrument Lists, Specification Forms, Logic Diagrams, Loop Diagrams
   b) Safety Standards of Industrial Automation
   c) Programming Programmable Logic Controllers Hardware Configuration, Programming Languages (Ladder Diagrams, Function Block Diagrams)

d) Control Applications for Industrial Automation
   i) Open Loop Control
   ii) Feedback Control

Grading Policy

Homework (15%): Homework is an essential component of the learning experience in this course. Students who successfully complete and understand all the assigned homework problems will find themselves well prepared for the written tests. Content and numerical results are certainly important in homework problems, but problem presentation is of equal importance. This includes a well-conceived diagram containing all information pertinent to the problem, an algebraic solution for the desired quantity in terms of given/known quantities, correct and consistent use of notation, units, and significant figures, as well as overall neatness and clarity. The assigned homework problems will be collected during class periods as detailed in the course schedule, and two or three of them will be graded. The lowest homework problem grade for the semester will be dropped. Each submission may include two students' names, and problems are graded according to the rubric:

Proper submission including diagram with given quantities when appropriate (2 points)
Correct identification of problem solution method (2 points)
Significant progress made towards solving the problem (2 points)
Correct and consistent use of units (2 point)
Algebraic expressions carried out as far as possible (1 point)
Answer obtained correctly to 3 significant figures (1 point)

Group exercises (15%): Most lecture periods with a reading assignment will begin with a "five-minute" group exercise. The purpose of these exercises is to stimulate learning of new material in groups of two5 members. Questions on group exercises will be short and generally require only that students have thoroughly read the day's reading assignment. Examples of question topics include definitions, identifying symbols or notation, and drawing/interpreting diagrams. The lowest group exercise grade for the semester will be dropped. Group exercises are graded out of 4 points, and any honest attempt at answering the question will receive at least 2 points.

Laboratory exercises (20%): All students are expected to attend the lab sessions and will be assigned zero grades for missed sessions. Two types of lab assignments are used in this course. The simplest involves collecting data during the session, answering some relatively simple questions, and perhaps demonstrating successful operation for the instructor. The assignments will be graded before or at the end of the lab session. The other type of lab assignment will span two or more lab sessions, include design elements with more involved calculations, and be submitted in electronic form by emailing a digitally produced copy to kmcfall@spsu.edu by the beginning of the lab session immediately following completion of the assignment. The average grade from each type of lab assignments will be assigned to half of the laboratory grade, i.e. each fill 10% of the final grade.

Tests (2x15%): Two in-class tests will be used to assess progress in thecourse. Calculators will be allowed on the test, as will one hand-written 3×5 card equation sheet. The tests, in general, will be curved in an attempt to maintain an overall class average of a mid C.

Final project (20%): A final project will be assigned for which a report must be submitted by email to kmcfall@spsu.edu by the end of the semester. Project performance is assessed by a fully word-processed technical report of professional quality. Information retrieved from any source other than the course textbook must be cited in the report. Reports will be assessed 80% for content and 20% for presentation.

The scale for the final course grade is as follows:

A	90-100
B	80-89
C	70-79
D	60-69
F	0-59

Attendance Policy

Forcing everyone to come to every class is not practical. Each student bears responsibility for material covered in class. If you choose to miss class, that is your decision. However, completion of group exercises goes hand-in-hand with attendance. Note also that late arrival to class will result in working alone on group exercises. Class time will be spent primarily working problems, under the assumption that all students have read and understood the day's reading assignment. In general, late assignments are not accepted nor can make-up tests be administered. Extenuating circumstances can result in exceptions to this rule, but agreement must be reached with the instructor in advance of the assignment or test which will be missed. Laboratory attendance is mandatory; students will receive a grade of zero for missed lab sessions.

Academic Misconduct

At SPSU, academic misconduct is defined as "any act that could have resulted in unearned advantage or that interferes with the appropriate academic progress of others". All acts of academic misconduct will be reported to the Honor Council. For more information see www.spsu.edu/honorcode. The application of the definition of academic misconduct for each category of assignment in this course is describes as follows:

Discussion of homework problems among peers and even other sources is wholeheartedly encouraged. A single homework submission is allowed for groups of no more than two members. Note, however, that this submission must be a reflection of the group's work alone. Multiple submissions may appear similar if the same solution process is followed, but they may not be copied, not even in part. Be aware that copying of any kind from any source, including clandestine solution manuals, will be considered a violation of academic integrity. If you have a copy of the solution manual, you are strongly recommended to delete it. Using the solution manual as a crutch when solving homework is detrimental to your learning, and the temptation is great to rely heavily on it when rushed to complete a homework set. The majority of reported academic integrity violations in this course result from students copying from the solution manual. Additionally, possession of the solution manual is unnecessary as you will be provided with detailed solutions of all homework problems after they are due, as well as for non-assigned problems upon request.

Collaboration among group members during group exercises, laboratory assignments, and the final project is obviously encouraged, but assistance of any kind from outside the group will be considered a violation of academic integrity. Any material outside of the course textbook must be appropriately cited in the final project report.

Tests are to be reflections of the individual's work alone. Assistance other than a calculator and the approved equation sheet, including connected devices, other class members, etc. will be reported as a violation to the Academic Integrity Committee.

Disability Statement

If you have a documented disability as described by the Rehabilitation Act of 1973 and the Americans with Disabilities Act (ADA) that may require you to need assistance attaining accessibility to instructional content to meet course requirements, please contact the ATTIC at 678-915-7361 as soon as possible. It is then your responsibility to contact and meet with the instructor. The ATTIC can assist you and the

instructor in formulating a reasonable accommodation plan and provide support for your disability. Course requirements will not be waived but accommodations will be made, when appropriate, to assist you to meet the requirements.

Communication

Course material will be disseminated in GeorgiaView Vista including lecture notes, homework solutions, etc. All official course announcements, including instructions when class may be cancelled, will be sent to the students' official SPSU email. Be sure to check your SPSU email regularly.

Course Schedule

Day	Date	Description	Reading	Homework due
Wed	08/15	Introduction		
Fri	08/17	Measurement systems	1.1-2.2	
Mon	08/20	Dynamic measurements	2.3-2.4	
Wed	08/22	Amplification	3.1-3.2.3	
Fri	08/24	Filters	3.2.4-3.2.5	
Mon	08/27	Integration and differentiation	3.2.6-3.4	2.2, 2.15, 2.20, 2.28, 2.38, 3.1, 3.8, 3.21
Wed	08/29	Number representation in computer systems	4.1-4.2	
Fri	08/31	Data-acquisition	4.3-4.5	
Wed	09/05	Sampling	5.1-5.2, 5.4	4.11, 4.16, 4.23, 4.31
Fri	09/07	Fourier transform	5.3	
Mon	09/10	Probability of discrete random variables	6.1-6.3	
Wed	09/12	Probability of continuous random variables		
Fri	09/14	Parameter estimation	6.4-6.5	5.11, 5.15, 5.16, 5.31
Mon	09/17	Least squares linear fit	6.6-6.6.3	
Wed	09/19	Nonlinear curve fitting	6.6.4-6.8	
Fri	09/21	Recitation		
Mon	09/24	Review		6.4, 6.29, 6.41, 6.47, 6.62, 6.77, 6.82, 6.91
Wed	09/26	Test 01		
Fri	09/28	Systematic and random uncertainties	7.1-7.4	
Mon	10/01	Uncertainty in experiments	7.5-7.8	
Wed	10/03	Uncertainty in data-acquisition systems	7.9-7.10	
Fri	10/05	Recitation		
Mon	10/08	Measuring strain	8.1	
Wed	10/10	Measuring position, speed, and acceleration	8.2-8.5	7.2, 7.21, 7.40, 7.51, 7.57
Fri	10/12	Recitation		
Mon	10/15	Measuring force and torque	8.6-8.7	
Wed	10/17	Measuring pressure	9.1-9.1.2	8.16, 8.18, 8.26, 8.29, 8.33
Fri	10/19	Recitation		
Mon	10/22	Measuring temperature	9.2-9.2.3	
Wed	10/24	Measuring flow	10.1-10.1.1	8.48, 8.49, 8.53, 9.14, 9.15
Fri	10/26	Recitation		
Mon	10/29	PLC basics	1.1-1.6*	
Wed	10/31	Ladder logic	6.1-6.11*	9.21, 9.29, 10.4, 10.14
Fri	11/02	Class cancelled		
Mon	11/05	Timers	7.1-7.6*	
Wed	11/07	Counters	8.1-8.6*	5.1, 5.9, 6.9, 6.10, 7.13*
Fri	11/09	Test 02		
Mon	11/12	Process control	14.1-14.5*	
Wed	11/14	Project		
Fri	11/16	Project		
Mon	11/19	Project		
Mon	11/26	Project		
Wed	11/28	Project		
Fri	11/30	Project		
Mon	12/03	Project		

This course schedule is subject to modification depending on the pace of the course. However, homework assignments and test dates will not be changed unless students anonymously and unanimously vote for a change.

* These reading and homework assignments are in Programmable Logic Controllers 4th edition by Frank D. Petruzella. See the web link on Vista or http://www.scribd.com/doc/72908166/Programmable-Logic-Controllers. Another great resource is the Siemens Easy Book, also posted on Vista.