MONTANA TECH

Metallurgical & Materials Engineering Department

EMET 451 – Process Instrumentation and Control
Syllabus

Instructor: Dr. Jerry Downey (ELC 215; 496-4578) **Office Hours**: as posted

Course Description: The course examines how process instrumentation, including sensors, controllers, error detectors, transmitters, activators, and final control elements, are used on-line and off-line to measure and control process variables such as temperature, pressure, pH, level, flowrate, density, viscosity, etc. Control loops (feedforward, feedback, and ratio) and modes (discrete and PID) are covered along with state-of-the-art strategies (neural networks, fuzzy logic, and object-oriented simulation). Emphasis is placed on understanding the various sensors.

Credits and Class Meetings: The 3 credit (lecture) course meets from 10:00-10:50 MWF in ELC 327.

Designation: required for the Bachelor of Science degree in Metallurgical and Materials Engineering.

Prerequisites: PHSX 237 or EELE 201 or instructor consent.

Textbook and References: No required textbook. Supplemental reading may be assigned in class and/or posted by e-mail. Information and assignments are drawn from multiple references, which include:

1. Advanced Process Control, Cecil L. Smith, John Wiley & Sons, 2010, 450 pages (ISBN 978-0-470-38197-7)
2. Basic Process Measurements, Cecil L. Smith, John Wiley & Sons, 2009, 346 pages (ISBN 978-0-470-38024-6)
3. Practical Process Control: Tuning and Troubleshooting, Cecil Smith, Wiley-Interscience, 2009, 448 pages (ISBN 0470381939)
4. Process Systems Analysis and Control (3rd Edition), Donald R. Coughanowr and Steven E. LeBlanc, McGraw Hill, 2009, 602 pages (ISBN 978-0-07-339789-4)
5. A Real-Time Approach to Process Control, William Y. Svrcek, Donald P. Mahoney, and Brent R. Young, John Wiley & Sons, 2006, 325 pages (ISBN 13: 978-0-470-02533-8; 10: 0-470-02534-4)
6. Principles and Practice of Automatic Process Control (3rd Edition), Carlos A. Smith and Armando Corripio, John Wiley & Sons, 2006, 563 pages (ISBN 0-471-43190-7)
7. Process Control Instrumentation Technology (8th Edition), Curtis D. Johnson, Prentice-Hall, Englewood Cliffs, NJ, 2006, 694 pages (ISBN 0-13-119457-7)
8. Instrumentation and Control Systems, W. Bolton, Newnes (Elsevier), 2004, 339 pages (ISBN 0-7506-6432-0)
9. Design and Application of Process Control Systems, Armando B. Corripio, Instrument Society of America, 1998, 319 pages (ISBN 1-55617-639-2).
10. The OMEGA® Transactions and Vol. MM Master Index, Putnam Publishing Company and OMEGA Press, LLC, 1998

Course Content: The course is oriented to the perspective of a process engineer, who will be responsible for developing and interpreting piping and instrumentation diagrams (P&IDs), interfacing with instrumentation engineers and vendors, specifying equipment, and interpreting data obtained from process instrumentation and control systems. Subject matter includes an introduction to the standard process control configurations, controller principles, sensor and transmitter selection criteria, and final control elements. Correlations between control systems and fundamental material and energy balance calculations are emphasized. Consequently, the course augments process engineering and design courses as well as electronics/circuits and essentially helps to conclude the Bachelor of Science in Metallurgical and Materials Engineering program.

The tentatively planned lecture topics include:

1. Overview; process control incentives
2. Control system design aspects, configuration, and hardware
3. Control principles (input, output, set point, and error)
4. Discontinuous controller modes
5. Continuous controller modes (proportional, integral, derivative, and composite)
6. Process dynamics – material balances and control system design
7. Mechanical sensors (pressure and strain)
8. Level and flow sensors
9. Actuators and control valve characteristics
10. Liquid flow systems
11. Compressible gas flow systems
12. Process dynamics – energy balances and control system design
13. Furnace and heat exchanger control systems
14. Temperature measurement and thermal sensors
15. Chemical reactors
16. pH sensors
17. Chemical analyses (time permitting)
18. Data acquisition (time permitting)

Objectives and Outcome: graduates of this course will or will be able to:

1. Understand the purpose and operation of various control loop strategies.
2. Select appropriate instrumentation for specific control applications and process variables.
3. Gain a deeper appreciation for the value of accurate measurements in order to specify sampling, analytical, mass and energy balance, and metallurgical performance procedures.
4. Design and/or interpret the basic control system required for modern process facilities.
5. Evaluate process flowsheets and P&IDs to determine sensor locations for process control and/or data acquisition.

The course objectives and outcome are responsive to the following ABET Criteria for skills, knowledge, and behaviors:

(1) Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

(2) Apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, asocial, environmental, and economic factors

(10) Apply and integrate knowledge from each of the above four elements of the field using experimental, computational, and statistical methods to solve materials problems including selection and design consistent with the program educational objectives

Evaluation and Grading Criteria: grades will be determined according to the following formula:

Homework & Quizzes:	30% or 0.3 x (homework + quiz) average
50-min. Examinations:	55% or 0.55 x examination average
Term project & presentation:	15% or 0.15 x score

where

A = 90 to 100
B = 80 to <90
C = 70 to <80
D = 60 to <70
F = <60

Plus and minus grades may be assigned at the discretion of the instructor.

Each student receives feedback on his or her current class standing when graded examinations are returned. The feedback includes the student's exam score, the class average for the exam, the student's point total, the class average point total, and the student's current rank in the class. For example, the student with the 3rd highest point total in a class of 16 students is ranked as 3/16, while the student with the 15th highest point total in the same class is ranked at 15/16.

Examinations: Students are required to sit for three 50-minute examinations, which are tentatively scheduled for mid-February, mid-March, and mid-April. The instructor reserves the right to alter the examination schedule with at least one week advance notice to the class.

Examinations are graded on a 100-point maximum basis. Unless otherwise specified by the instructor, examinations are closed book and closed notes. In general, examinations cover the subject matter presented in class plus the reading assignments for the period subsequent to the preceding exam.

The final examination will be held according to the place, date, and time designated by the Registrar's Office at the beginning of the semester; no exceptions. The final exam comprises a semester-long design project and formal presentation. Students must submit their written design reports by the final day of classes and present their projects to the class during the designated class periods or the scheduled final examination period. The design project and presentation will be graded on a 100-point basis; grade components are: technical content (40%), professionalism (20%), structure and format (20%), and responsiveness (20%).

It is the student's responsibility to sit for the examinations at the scheduled dates and times. If a student misses one of the scheduled 50-minute examinations for any reason, the sole recourse is make arrangements with the instructor to sit for a make-up exam. The make-up examinations will be scheduled for a mutually convenient date and time. The instructor must receive the written request for the make-up examination within at one week following the missed examination. Students are cautioned to arrive early as those who are not present at the designated starting time will not be allowed to take the examination. Each student is allowed one (1) make-up examination due to unexcused absence. An examination missed without make-up is assigned the grade of zero (0).

Homework: Reading, design, and problem-solving assignments, are distributed in class and/or distributed by e-mail. Each homework assignment is graded on a 100 point basis. The homework cover sheets specify the due date. Homework must be submitted to the instructor prior to the start of class on the due date. Except in cases of excused absence, late work is not accepted and receives the score of zero.

Students are encouraged to work in groups, but each student is personally responsible for completing and submitting the assignments. In order to receive full or partial credit, problem solutions that involve computations and/or derivations must show all steps, state assumptions, express the answers using proper engineering units, and clearly indicate the final answer. Homework is expected to be well-organized and legible with correct spelling and grammar. Illegible or incomplete work is returned with a score of zero.

Quizzes: generally intended to reinforce the learning process, quizzes may be given with or without advance notice (i.e. a "pop quiz"). Subject matter covered during the previous and present lecture and/or the associated readings is considered fair game. The pop quiz frequency correlates directly to the occurrence of classroom disruptions during lecture. Potential disruptions include but are not necessarily limited to: late arrivals or early departures by students, extraneous conversations, cell phone usage, text messaging, etc. Each quiz is graded on a 100-point basis and there is no limit to the number of quizzes that may be given during the semester. Make-up quizzes are not given in instances of unexcused absence.

Absence: class attendance will be recorded but is not a factor in the assessment and grading criteria. However, the student is responsible for all material discussed in class, whether or not the student chooses to attend.

Students must submit their assignments in advance of field trips, athletics, or other school-sanctioned events that cause them to miss class the day that the assignment is due. The student is responsible for notifying the instructor and submitting homework assignments prior to the absence. Following an absence, students are advised to obtain class notes from another student. Under no circumstances will students be granted access to the instructor's lecture notes or grading keys.

Montana Tech policy dictates that "faculty should make reasonable accommodation for students to make-up work missed (or the equivalent) because of an excused absence. Excused absences include official Montana Tech events or activities, or personal matters deemed appropriate by the instructor."

Official Montana Tech Events or activities include:

- NAIA sanctioned sporting events
- Academic Team competitions
- Travel for professional meetings related to major
- Class field trips
- Others as approved by the Chancellor

Academic Integrity: Students enrolled in the Metallurgical and Materials Engineering courses are expected to maintain an integrity standard that is consistent with the applicable fundamental canons of the NSPE Code of Ethics for Engineers. Specifically, students are expected to conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Academic dishonesty or cheating will not be tolerated. Students are expected to adhere to the Montana Tech Academic Honesty policy (see addendum and/or the Montana Tech student handbook).

If it is determined that a student has deliberately cheated on a report, quiz, or examination, the student will be dropped from the course with an “F” grade. In compliance with Montana Tech policy, all cases of academic dishonesty will be reported to the Office of the Vice Chancellor for Academic Affairs.

With one exception, the Department policy is that electronic devices are not to be activated or evident during lectures, quizzes, and examinations. This restriction includes but is not limited to programmable calculators, cell phones, laptop computers, mp3 players, dvd players, and all types of recording devices. The exception is that students are permitted to use a nonprogrammable calculator during lectures, quizzes, and exams.

Students that possess unapproved calculators or other electronic devices during a quiz or exam are subject to dismissal from the classroom.

No student is allowed to record, tape, or photograph any classroom or laboratory activity without the express written consent of the instructor.

Disability Accommodations: Students that need academic accommodation because of disabilities must:

1. Register with and provide documentation to the Montana Tech Student Disability Coordinator
2. Provide the instructor with a letter that states the need and type of accommodation. This should be done during the first week of class.

In case that a student believes that he/she needs to record or tape classroom activities due to disability, the student must request an appropriate accommodation. In the event that such an accommodation has been arranged, the material may not be further copied, distributed, published, or otherwise used for any other purpose without the express written consent of the instructor.

Professional Component:

Engineering Topics:	100%
Design Component:	Yes
Computer Usage:	Yes
Ethics:	Yes
Statistics:	No
Safety:	No

Prepared by: J. Downey
Finalized: <enter date each semester>