MONTANA TECH  
Metallurgical & Materials Engineering Department  

M&ME 4510 – Process Instrumentation and Control  
Spring 2011 Syllabus  

Instructor: Dr. Jerry Downey (ELC 215; 496-4578)  
Office Hours: 9:30 to 11:00 a.m. TR  

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 9:00-9:50 MWF in ELC 202.

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

Prerequisites: METE 2500, CHMY 373 (formerly CHEM 3356), or ENGR 3340; or Consent of Instructor.

Textbook and References: No required textbook. Supplemental reading may be assigned in class and/or posted on Blackboard. Information and assignments will be drawn from multiple references, which include:


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 a-k Criteria) skills, knowledge, and behaviors:

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, or sustainability.
(d) an ability to function on multidisciplinary teams

In concert with the stated Metallurgical and Materials Engineering Department outcomes, graduates of this course will also:

(i.) be able to apply advanced math, science (chemistry and physics), and engineering principles to metallurgical and mineral systems, and
(n.) be able to apply and integrate knowledge from each of the four elements of the field to solve metallurgical and materials selection and design problems.

**Evaluation and Grading Criteria:** Each student is credited with 1,000 points at the beginning of the semester. Thereafter, points are deducted from the student’s “account” based on his/her performance relative to the grading criteria outlined below. As examples, a student who receives a score of 90 on a typical 100-point exam will have 10 points deducted from his/her account and a student who receives a score of 17 on a typical 20-point homework assignment will have 3 points deducted from his/her account.

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.

The number of points that the student retains at the end of the semester determines the student’s grade for the course. **Students with less than 600.0 total points after the final exam receive an “F” regardless of where the**
**final curve falls.** With these exceptions, individual grades (A, B, C, D, and F) are decided according to the natural breaks in the curve. The 1,000 point maximum is distributed as follows:

- Attendance and quizzes (variable, depending on student compliance)
- Notebook (50 points)
- Homework (250 points)
- 50-minute examinations (4 x 100 = 400 points)
- Final examination/design project (200 points)

**Attendance:** Students are expected to attend at least 90% of the lectures. Role is taken at the beginning of class. Ten (10) points are deducted from the student's point total on the fifth absence and on each subsequent absence. Students who arrive after role has been taken or depart prior to dismissal are considered absent.

Students must submit their assignments in advance of field trips, athletics, or other school-sanctioned events that force them to miss class. The student is responsible for notifying the instructor, submitting homework assignments, and sitting for examinations prior to the absence. Students should arrange to obtain class notes from another student. Never ask to borrow the instructor's lecture notes or grading keys.

**Examinations:** Students are required to sit for four 50-minute examinations. Each examination is graded on a 100-point basis. Unless otherwise specified by the instructor, the examinations are closed book and closed notes. In general, the examinations cover the subject matter presented in class and the reading assignments for the period subsequent to the preceding exam. The 50-minute examinations are tentatively scheduled for February 9, March 7, April 6, and May 2. The instructor reserves the right to alter the examination schedule with at least one week advance notice to the class.

The Registrar’s Office has scheduled the final examination time for this course to take place from 8:00 to 10:00 am on Tuesday, May 10, 2011. The final exam comprises a semester-long design project and formal presentation. Students must submit their written design reports by 9 a.m. on Wednesday, May 4, 2011, and present the results of their projects to the class during the May 4 or May 6 class periods or during the scheduled final examination period. The final will be graded on a 200-point basis.

It is the student’s responsibility to sit for the examinations at the scheduled dates and times. As a general rule, make-up examinations are not given for unexcused absences. Exceptions are decided on a case-by-case basis for unavoidable absences resulting from sudden illness or other extreme emergencies.

**Homework:** Reading, design, and problem-solving assignments, are distributed in class and/or posted on Blackboard. The homework cover sheets (posted on Blackboard and/or distributed in class) specify the due date. Homework must be submitted prior to the start of class on the due date. Late work is not accepted and receives the grade of zero. Students are encouraged to work in groups, but each student is personally responsible for completing and submitting the completed 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.

**Quizzes:** Generally intended to reinforce the learning process, quizzes may be given with or without (i.e. a “pop quiz”) advance notice. 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 question is graded on a 10-point basis and there is no limit to the number of quizzes that may be given during the semester.

**Notebook:** Students are expected to organize their lecture notes, supplemental reading and reference materials, graded homework and examinations, and other course materials in a three-ring binder. Students are required to submit their notebooks for grading on May 2. The notebooks are graded on a 50-point basis.

**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.
Acts of academic dishonesty include (but are not limited to):

- Plagiarism
- Copying from another student’s paper while taking a quiz or examination
- Using unlawful aids (books, notes, cell phones or other electronic devices, etc.) to pass an examination (unless the instructor has clearly stated that it is an open notes or open book exam)
- Assisting another student in an act of academic dishonesty

If it is determined that a student has deliberately cheated on a quiz, examination, or assignment, he or she will be dropped from the course with an “F” grade. In compliance with Montana Tech policy, 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 and examinations. This restriction includes but is not limited to programmable calculators, cell phones, Ipods, or entertainment devices. The exception is that students are permitted to use a nonprogrammable calculator during some lectures, quizzes, and exams; however, calculators of any type will not necessarily be permitted for all quizzes and exams. Students that possess unapproved calculators or other electronic devices during a quiz or exam are subject to dismissal from the classroom. Penalties for disregarding the policy during lecture will be enforced at the instructor’s discretion.

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

1. Register with and provide documentation to the Student Disability Coordinator (Joyce O’Neill, Engineering Hall Room 104; 406-496-4429; joneill@mtech.edu)
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.

Professional Component:

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Prepared by: J. P. Downey January 10, 2011