INSTRUMENTATION & PROCESS CONTROL W/ LAB
CHT 2200

Class Hours: 2.0   Credit Hours: 3.0
Laboratory Hours: 3.0   Date Revised: Fall 2001

NOTE: This course is not designed for transfer credit.

Catalog Course Description:
A study of automatic control of processes and equipment. Topics include process dynamics, feedback control, controller tuning and a survey of equipment used in process control. Course includes two hours of lectures and three hours of laboratory applications each week.

Entry Level Standards:
All students should have completed a college algebra course.

Prerequisite:
MATH 1731

Textbook(s) and Other Reference Materials Basic to the Course:

I. Week/Unit/Topic Basis:

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II. Course Objectives*:

A. Measure and/or estimate the response of a process element with time. I, II, III
B. Set up and/or analyzing a feedback control system for a process variable. I, II, III
C. Tune a proportional-integral-derivative controller. I, II, III
D. Make simple programs and/or program modifications on a programmable controller. I, II, III, IV, V
E. Select an appropriate sensor for measuring a process variable. I, II, III, V
F. Select an appropriate final control element. I, II, III, V
G. Operate a control computer and tuning parameters in the control loops. I, II, III, V

*Roman numerals after course objectives reference goals of the Chemical/Environmental Engineering Technology program.

III. Instructional Processes*:

Students will:

1. Attend lectures and discuss concepts. Communication Outcome, Problem Solving and Decision Making Outcome, Information Literacy Outcome, Active Learning Strategy
2. Solve assigned problems out of class and be prepared to discuss the problem solutions. Communication Outcome, Problem Solving and Decision Making Outcome, Numerical Literacy Outcome, Information Literacy Outcome, Active Learning Strategy
3. Use the library and other sources to prepare and deliver an oral presentation describing a new process sensor. Communication Outcome, Problem Solving and Decision Making Outcome, Technological Literacy Outcome, Information Literacy Outcome, Active Learning Strategy
4. Participate in laboratory experiments which are direct applications of the concepts studied. Communication Outcome, Problem Solving and Decision Making Outcome, Information Literacy Outcome, Active Learning Strategy, Transitional Strategy
5. Perform laboratory experiments, collect data and keep a research style lab notebook. Communication Outcome, Problem Solving and Decision Making Outcome, Technological Literacy Outcome, Information Literacy Outcome, Active Learning strategy

*Strategies and outcomes listed after instructional processes reference Pellissippi State’s goals for
strengthening general education knowledge and skills, connecting coursework to experiences beyond the classroom, and encouraging students to take active and responsible roles in the educational process.

IV. Expectations for Student Performance*:

Upon successful completion of this course, the student should be able to:

1. Calculate the approximate time constant for simple real systems given the approximate resistance and capacitance.  A
2. Calculate the approximate time constant for a thermometer.  A
3. Calculate the time constant for a liquid storage tank.  A
4. Use the differential equation solution to calculate the time required for a given response in a first order system.  A
5. Test a system for its response to sinusoidal or pulse testing.  A
6. Sketch a process control system for pneumatic level control showing the air lines to and from each piece of equipment.  B
7. Label the standard feedback control diagram and show how it applies to a specific control system.  B
8. Describe the difference between feedback control and feed forward control.  B
9. Diagram a control system using feed forward control.  B
10. Set up a pneumatic level control system, operate the system and troubleshoot.  B
11. Take experimental data from an open loop test and calculate the controller settings.  C
12. Take experimental data from a closed loop test and calculate the controller settings.  C
13. Tune a controller using a search method.  C
14. Read the ladder diagram for a programmable controller and modify it to give a desired response.  D
15. Write a programmable controller program, do the programming, operate the process and troubleshoot the program.  D
16. Obtain process sensor information from library reference material and from equipment vendor literature.  E
17. Select the appropriate process sensor for different processes based on limitations of various sensors available.  E
18. Obtain final control element information from library reference material and from equipment vendor literature.  F
19. Select the appropriate final control element for different processes based on limitations of various elements available.  F
20. Operate a control system using a digital control system to obtain system data and tune the control loops.  G
21. Operate a control system using a digital computer to obtain system data and tune two control loops in cascade control. G

22. Describe the advantages of pneumative controllers, electronic controllers, and computer controllers.

23. Learn to set up a pH control system. G

*Letters after performance expectations reference the course objectives listed above.

V. Evaluation:

A. Testing Procedures:

Three exams will be given during the semester, and a final exam will be given at the end of the semester.

B. Laboratory Expectations:

Each student will keep a research type laboratory notebook and write up each experiment in the notebook.

LABORATORY EXPERIMENTS:

1. Process Dynamics
   The time constant will be determined for thermometers and other process sensors.

2. Process Dynamics
   An analog computer will be used to show the effect of multiple time constant elements in series.

3. Pneumatic Controller
   A level control system will be set up and operated. Each student will install the tubing and operate the system by themselves.

4. Pneumatic Controller
   The controller will be tuned (using the ultimate gain method) for a level control system.

5. Electronic Controller
   An electronic controller will be used for humidity control. The auto tune function and tuning by the ultimate gain method will be compared.

6. Pneumatic Controller
   A flow control system will be set up and operated.

7. Automatic Controller
   An analog computer simulation of a 2 mode controller and a process will be set up, tuned and operated.

8. Computer Control
   The flow control loop will be tuned using the digital control demonstrator.

9. Computer Control
   The level control loop will be tuned using the digital control demonstrator.

10. Computer Control
    The temperature control loop will be tuned using the digital control demonstrator.
11 Computer Control
   The temperature in a line will be controlled using cascade control with the digital control demonstrator.

12 Programmable Controller
   A programmable controller program will be modified and the results verified in operation.

13 Final Control Elements
   Several control valves will be examined.

14 Process Sensors
   Several process sensors will be examined.

15 pH control
   A pH control system will be set up and tuned.

16 Digital to analog controller module
   The level control loop for the digital control demonstrator will be adjusted using hexadecimal commands.

C. Field Work:

   Each student will submit a research paper on a process sensor that has not been covered in the lectures and give a short talk in a laboratory class on the process sensor. Material for the paper and talk will come from the school library, the catalog library in the laboratory and the Internet (and other sources as needed).

D. Other Evaluation Methods:

   Homework will be assigned and collected. The homework turned in will be assigned a grade of A. Any homework not turned in will not effect the grade.

E. Grading Scale:

   The course grade will be determined by the formula below:
   \[ G = \frac{2}{3}\left(\frac{.55t + .35f}{.9 + .1h} + 10h\right) + \frac{1}{3}L \]
   Where
   \[ t = \text{Exam average grade} \]
   \[ f = \text{Final exam grade} \]
   \[ h = \text{(Homework turned in)} \]
   \[ (\text{Total homework assigned}) \]
   \[ L = \text{Laboratory grade} \]

   Letter grades will be awarded based on the following schedule:
   - 90 – 100   A
   - 87 – 89     B+
   - 80 – 86     B
   - 77 – 79     C+
   - 70 – 76     C
   - 60 – 70     D
   - below 60    F

VI. Policies:
A. Attendance Policy:

Pellissippi State Technical Community College expects students to attend all scheduled instructional activities. As a minimum, students in all courses must be present for at least 75 percent of their scheduled class and laboratory meetings in order to receive credit for the course (Pellissippi State Catalog). Individual departments/programs/disciplines, with the approval of the vice president of Academic and Student Affairs, may have requirements that are more stringent.

Chemical/Environmental Engineering Technology Program:
Regular attendance in this course is required. Students who miss the equivalent of 10% of either classroom hours or laboratory may, at the discretion of the instructor, have their course grade dropped by one letter. Students who arrive late for a class after the roll as been called have the responsibility of seeing the instructor after class the change their status from A (absent) to T (tardy).

B. Academic Dishonesty:

In keeping with college-wide policies, the student is expected to adhere to the general rules and regulations relevant to academic and classroom misconduct as outline in the catalog.