North Central State College
COURSE SYLLABUS
2009-2010

A. **Course Number and Title:** ELM 230—Process Controls

B. **Academic Division:** Technology and Workforce Development

C. **Department:** Technology
Program: Electronic Engineering – Electrical Maintenance Option

D. **Lecture Hours:** 2

E. **Lab Hours:** 3

F. **Credit Hours:** 4

G. **Prerequisites:** can be concurrent with ELM 224

H. **Course Description from Catalog:** A study of industrial automated process control systems using programmable controllers. Emphasis will be on programming, signal conditioning, and data transfer.

I. **Textbook:**

1. Title: *LabView 8 Student Edition*
   Author: Bishop
   Publisher: Pearson Prentice Hall
   (Same text as ELM 130)

J. **Workbook(s) and/or Lab Manual(s):** None

K. **Purpose of Course:** To expose students with a background in electrical controls and PLC to the filed of process instrumentation and PLC technology.

L. **Supplies Needed:** Supplied by NC State or part of the Lab Fee.

M. **Course Outcomes/Assessment Procedures:**

The following Core Learning Outcomes are addressed in this course:

Core Learning Outcome	
Communication – Written	
Communication – Speech	
Culture and Community	
Critical Thinking	
Computer Literacy	
Computation	

Upon successful completion of this course; the student will be able to:

Outcomes	**Assessments**

1. define temperature.
2. describe the difference between the Fahrenheit and Celsius temperature scales.
3. describe how Rankine and Kelvine scales relate to Fahrenheit and Celsius scales.
4. define heat
5. describe the process of heat transfer by conduction, convection, and radiation.
6. identify the three phases of matter.
7. define latent heat and sensible heat.
8. describe the relationship between temperature and sensible heat
9. explain why there is no relationship between temperature and latent heat.
10. define pressure
11. demonstrate an understanding of the relationship between force, area, and pressure and explain how pounds per square inch (psi) as a unit of pressure is derived from this relationship.
12. demonstrate an understanding of atmospheric pressure and its effect on gage pressure and absolute pressure measurements.

13. demonstrate an understanding of the relationship between gage pressure measurements and absolute pressure measurements.
14. demonstrate an understanding of the concept of measuring pressure in terms of the height of a column of liquid, and be able to convert pressures given in inches of water or mercury to pounds per square inch.
15. define specific gravity.
16. define volume and level.
17. demonstrate an understanding of the operation of a sight glass.
18. demonstrate an understanding of hydrostatic head as related to level measurement.
19. identify the types of systems in which wet leg and dry leg differential measurement systems are used.
20. differentiate between volumetric measurements and mass measurements, and be able to calculate the mass content of a container, given its dimensions, the level of fluid it contains, and the density of the fluid.
21. demonstrate an understanding of the construction and operation of bimetallic thermometers.
22. demonstrate an understanding of the construction and operation of thermocouples.
23. demonstrate an understanding of the construction and operation of resistance temperature detectors.
24. demonstrate an understanding of the construction and operation of thermistor temperature detectors.
25. define variable.
26. describe the function of instrumentation systems.
27. list the steps in a control process.
28. describe the difference between manual and automatic control.
29. identify process control variable.
30. define the terms upset, feedback, and feedback control loop.
31. identify the components of a typical feedback control loop and describe their functions.
32. define response time.
33. describe the difference between the terms accuracy and precision.
34. describe how changes in process variables can be converted to instrument signals.
35. describe the types of standard instrument signals.
36. describe the standard range of electronic and pneumatic transmission signals.
37. list some common types of final control elements.
38. describe how control valves are positioned electrically and pneumatically.
39. describe the difference between a single feedback control loop and a multiple-loop control.
40. describe the operating principles of cascade control, ratio control, and feed forward control.
41. describe the function of a controller in a process loop.
42. identify the four modes of control.
43. describe the operating principles of two-position control.
44. describe the effect of two-position control in a process loop.

45. describe the function of continuous control.
46. describe the operating principle of proportional control.
47. define proportional band.
48. describe the effects of changing the width of a proportional band.
49. explain the importance of having the proper amount of proportional control.
50. define offset.
51. describe the function of integral control.
52. describe the function of derivative control.
53. list and describe the characteristics of a process.
54. define working fluid.
55. describe the difference between a system and a process.
56. describe the difference between and open and a closed system.
57. define energy as it relates to fluid processes.
58. define flow rate, mass flow rate, and volumetric flow rate and the units commonly associated with each type of measurement.
59. demonstrate an understanding of the relationship between fluid flow rate and differential pressure across a flow restriction.
60. describe how flow rate can be determined using orifices, venturi tubes, flow nozzles, and piping elbows as primary elements.
61. describe how flow rate can be determined with magnetic vortex shredders and axial turbine flowmeter.
62. define and instrumentation diagram.
63. identify the function of instrument symbols.
64. describe instrument symbols and what they tell us about the instruments.
65. describe how balloon symbols indicate how instruments are mounted.
66. identify and interpret a functional identifier in a balloon symbol.
67. define a loop.
68. identify a loop identification number.
69. describe and interpret a loop indicator suffix.
70. describe the function of line symbols.
71. identify process line symbols.
72. identify signal line symbols.
73. identify the symbols used to represent different types of valves.
74. define an actuator.
75. identify the symbol for a hand actuator.
76. identify the symbols for automatic actuators such as a diaphragm actuators, solenoid actuators, and rotary actuators.
77. use instrumentation symbols to interpret a simple loop on an instrumentation diagram.
78. define loop diagram.
79. identify the sections on a loop diagram and the information found in each section.
80. identify the symbol for an instrument port or connection.
81. describe a junction box and its identifier.
82. identify the symbol for an instrument port of connection.

83. recognize the operating range and set point for an instrument.
84. identify and interpret the symbol for controller action.
85. identify the information or notes located in the blocks at the bottom of a loop diagram.
86. use instrumentation symbols to interpret an electronic loop diagram and a pneumatic loop diagram.
87. describe the importance of mechanical connections in instrumentation and control loops.
88. demonstrate how to check for leaks in a tubing installation.
89. explain the importance of proper electrical connections in process control loops.
90. describe the types of wires used in electrical connections.
91. explain how electrical noise can distort an instrument signal.
92. describe how shielded cable can be used to protect electronic signals from noise.
93. describe an unintentional ground loop.
94. demonstrate one method of tracing a signal in an electrical circuit.
95. identify two ways instruments can be made safe for use in hazardous locations.
96. define intrinsic safety.
97. describe an intrinsically safe system.
98. define standard.
99. describe two basic types of standards.
100. explain the purpose of each type of standard.
101. define manometer.
102. describe the characteristics and operation of U-tube manometers.
103. demonstrate how to read U-tube manometer scales.
104. describe the characteristics and operation of well-type manometers.
105. demonstrate how to read well-type manometer scales.
106. define meniscus.
107. demonstrate how to determine manometer levels.
108. describe the characteristics of ill fluids used in manometers.
109. explain the characteristics and operation of inclined manometers.
110. demonstrate how manometers can be used as primary standards.
111. define deadweight tester.
112. describe the parts and operation of a deadweight tester.
113. describe how to set up a hydraulic deadweight tester for a calibration.
114. explain how to calibrate a test gage using a hydraulic deadweight tester.
115. explain how pneumatic deadweight testers differ in construction from hydraulic deadweight testers.
116. explain the operation of pneumatic deadweight testers.
117. explain how to setup a pneumatic deadweight tester for calibration.
118. describe how to calibrate a secondary standard with a pneumatic deadweight tester.
119. define instrumentation error.
120. describe how instrumentation error can affect a process control loop.
121. describe the function of an input/output graph and the shape of an ideal calibration curve.

122. define accuracy, dead band, hysteresis, linearity, and repeatability in terms of instrument errors.
123. describe the effects of dead band, hysteresis, linearity, and repeatability on an ideal calibration curve.
124. explain five typical methods used to describe accuracy ratings.
125. describe the relationship between accuracy and range ability.
126. describe zero shift and explain how it is represented on an input/output graph.
127. define combination errors and explain how they are represented on an input/output graph.
128. describe the importance of correctly mounting measuring instruments.
129. define position errors and describe how to prevent them.
130. define parallax and describe how to prevent it.
131. interpret the divisions and subdivisions of different instrument scales.
132. explain the importance of instrument calibration.
133. identify conditions that may require an instrument to be calibrated.
134. select the test equipment required to calibrate pneumatic instruments.
135. describe a calibration setup for a pneumatic instrument.
136. explain calibration test equipment accuracy requirements.
137. explain the steps required to prepare an instrument for calibration, checking its calibration, and making calibration adjustments.
138. explain the importance of the upper and lower range test point selections.
139. given an instrument's output range, calculate the ideal output for each test point.
140. describe a five point calibration check on a pneumatic instrument, including what data to record.
141. analyze calibration data for instrument errors.
142. explain the adjustments made to correct zero shift, span errors, and combination errors.
143. verify that adjustments have brought the pneumatic instrument into calibration.
144. explain the advantages of a five-point check over a three-point check.
145. select the test equipment required to calibrate electronic instruments.
146. describe a calibration setup fro an electronic instrument.
147. explain the input and output connections required to calibrate an electronic instrument.
148. define a shared display.
149. define a shared controller.
150. define an Algorithm and its function.
151. explain a scanning device.
152. identify instrument symbols used on digital instrumentation diagrams.
153. use a simplified diagram.
154. use a conceptual diagram.
155. use a detailed diagram.

N. **Course Content:**

1. Process variables

    a. pressure
    b. level
    c. temperature
    d. flow

2. Process control modes

    a. two-position control
    b. proportional control
    c. integral control
    d. derivative control

3. Process characteristics

    a. process and system characteristics
    b. process energies
    c. process variables and measurements
    d. heat and heat transfer as a process variable

4. Instrumentation symbols

    a. line symbols
    b. valve symbols
    c. actuator symbols
    d. tag numbers
    e. simple loop diagram

5. Instrument loop diagrams

    a. loop sections
    b. port or connection symbols
    c. junction box symbols
    d. range, set point, and action symbols
    e. electronic/pneumatic loops

6. Process diagrams

    a. digital control
    b. identifiers
    c. process diagrams

7. Electrical connections

    a. grounds and shields
    b. signal tracing
    c. intrinsic safe systems

8. Primary calibration standards

    a. standards
    b. manometers
    c. hydraulic deadweight testers
    d. pneumatic deadweight testers

9. Instrument error

    a. characteristics of measuring instruments
    b. analysis of error
    c. position error
    d. span error

10. Instrument calibration

    a. calibration preparation
    b. pneumatic instrument calibration
    c. electronic instrumentation calibration

11. Process control systems

    a. computer control
    b. PLC control
    c. distributive control

O. **Planned Activities:**

Lectures, Test, Demonstrations

P. **Grading and Testing Guidelines:**

College Grading Scale:

100 to 95	A	79 to 77	C
94 to 92	A-	76 to 74	C-
91 to 89	B+	73 to 71	D+
88 to 86	B	70 to 68	D
85 to 83	B-	67 to 65	D-
82 to 80	C+	64 and Below	F

Late assignments = 10% per section

Labs	=	25%	(hands-on and paper)
Homework	=	10%	
Quizzes	=	20%	
Tests	=	45%	

(Approx. 8 wiring labs and 10 paper wiring labs)

Q. **Attendance Requirements**: All students are required to attend all scheduled classes and examinations. Each faculty member has the right to establish regulations regarding attendance that he/she considers necessary for successful study.

Students who do not attend classes may be administratively withdrawn from those classes. However, failure to attend classes does not constitute withdrawal, and students are expected to process a formal withdrawal through the Student Records if unable to complete a class.

R. **Other Specific Guidelines and Requirements**

The instructor reserves the right to deviate from the schedule based on time constraints and/or student's interests in spending more or less time on a particular topic.

S. **Statement on Disabilities**

Any student who requires reasonable accommodations related to a disability should inform the course instructor and the Coordinator of Specialized Services (Room 138 in Kee Hall; phone 419-755-4727).

Students who do not have a documented disability but who encounter difficulty in their courses are encouraged to visit the Student Success Center. The following are some of the services available to students: academic assistance, advising services, peer tutoring, personal counseling, and referral for LD testing. Students are welcome to come and discover the kinds of assistance available in the Student Success Center (Room 136 in Kee Hall; phone 419-755-4764).

T. **Statement on Withdrawals**

As a student, you are expected to attend class. If you are unable or choose not to attend class, or if for whatever reason you are unable to keep up with the requirements of a course, you need to officially drop the class at the Student Records Office. You may do this up to the end of the eighth week during a regular eleven-week quarter and up to the end of the fifth week during an eight-week term. Classes not following an eight or eleven-week schedule have different withdrawal and refund dates. Contact the Student Records Office for applicable dates. "The last day to officially drop a class is posted on the academic calendar available on the college's website, www.ncstatecollege.edu, under the Academics heading on the home page, is available at the Student Records Office in Kee Hall, and is published in the college's catalog." If you registered for classes in the Student Success Center, you should return there to officially withdraw from any classes. All other students should go to the Student Records Office to process their withdrawal from any class.

If you choose to walk away from your class without officially withdrawing from it, the faculty member teaching the class must grade your classroom performance on the material available to him or her. This normally results in an "F" grade. An "F" grade can lower your grade point average considerably depending on the total credits accumulated.

U. **Statement of Academic Dishonesty/Plagiarism/Copyright Infringement**

It is the position of the College that the responsibility for academic honesty is that of the student. It is expected that the student's work will be the product of his/her own efforts unless the student clearly indicates otherwise. Academic honesty is an important element of mature, responsible learning.

Dishonest scholarly practices include but are not limited to appropriating, in whatever form, another's work and submitting it as one's own (known as plagiarism), intentionally falsifying information, or taking another's ideas with the intention of passing these ideas off as one's own (also known as plagiarism).

In addition, cases of academic dishonesty may involve photocopied materials. Materials used may fall under the Copyright Act. Violations of said Act may subject the user and/or the College to sanctions. If you have questions whether a particular use is in violation of the Act, please contact the office of the Vice President for Learning.

V. Classroom Conduct

All students are expected to demonstrate professional behavior and use language appropriate for the classroom learning experience.