

SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

COURSE OUTLINE

Course Title: AUTO CONTROL SYSTEMS

Code No.: ELN 208-3

Program: INSTRUMENTATION TECHNI^{C-A}_{I-N}

Semester: 3

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New: _____ Revision: X

APPROVED: *R.P. Crozetta* CHAIRPERSON
DATE 85/09/09

ELN 208-3

PHILOSOPHY/GOALS:

To provide a basic understanding of pneumatic measurement and control applications.

GRADING:

- 1) Written tests conducted at regular intervals
- 2) Grading A -- 76 - 100%
 B -- 66 - 75%
 C -- 50 - 65%
 R -- less than 50%
- 3) 70% for tests
 30% for lab
- 4) Lecture and lab attendance mandatory

TEXTBOOK(S):

"Process Instrumentation and Control Fundamentals"
"Pneumatic Measurement and Control Fundamentals" by General Physics Corp.

Course Outline

Block 1 - Basic Mechanical Devices

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	1	
Levers		1
Pulleys		
The wheel and axle		1
Inclined plane		
The screw		1
Gears		
		<u>3</u>

Block 2 - Pneumatic Instrument Components and Subassemblies

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	2	
Levers		1
Beams		
Springs		1
Spring scale		
The bourdon tube		1
Diaphragms		
Bellows		1
The diaphragm capsule		
Bellows - spring subassembly		1
Diaphragm - spring subassembly		
Rolling diaphragm - spring subassembly		1
		<u>6</u>

Block 3 - The Flapper/Nozzle, The Pilot Valve, The Pneumatic Relay

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	3	
Restrictions		1
The flapper/nozzle detector		
Pilot motion detector		1
The pneumatic relay		
Direct acting bleed type relay		1
Reverse acting bleed type relay		
Direct acting non bleed type relay		1
		<u>4</u>

Block 4 - Force Balance Instruments

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	4	
The process variable transmitter, feed fwd. type		1
The displacement transmitter, feedfwd type		1
The variable indicator, feedfwd type		1
The proportional controller, feedfwd type		1
The actuator, feedfwd type		1
Feedback instruments		
Moment-balance feedback type instruments		1
Process variable transmitter, moment-balance feedback type		1
The motion transmitter, moment-balance feedback type		1
The variable indicator, moment-balance type		1
The proportional controller, moment-balance type		1
The actuator/positioner, moment-balance feedback type		1
True force-balance feedback type		1
The process variable transmitter, true force balance type		1
The motion transmitter, true force balance type		1
The variable indicator, true force balance type		1
The proportional controller, true force balance type		1
The actuator/positioner, true force balance type		1

		10

Block 5 - Motion-Balance Instruments

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	5	
Angle motion-balance feedback type		
The process variable transmitter, angle motion balance type		1
The motion transmitter, angle motion balance type		1
The recorder, angle motion balance type		1
The proportional controller, angle motion balance type		1
The actuator/positioner, angle motion balance type		1
Linear motion balance feedback type		
The process variable transmitter linear motion balance type		1
The motion transmitter, linear motion balance type		1
The recorder, linear motion balance type		1
The proportional controller, linear motion balance type		1
The actuator/positioner, linear motion balance type		1

		6

Block 6 - Pneumatic Measurement Instruments

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	6	
Temperature measurement instruments		1
Foxboro model 12A temp. transmitter		
Moore series 33 temp. transmitter		1
Pressure measurement instruments		
Foxboro model 45 pressure transmitter		1
Taylor 210 pressure transmitter		
Flow measurement		1
GC-11 differential press. transmitter		
Foxboro model 557 square root extractor		1
Low signal cutoff		
Level measurement instruments		1
Foxboro model 13 differential pressure transmitter		
Fisher controls level-trol transmitter		1
Pneumatic indication instruments		
Moore series 2000 recorder		1

		8

Block 7 - Pneumatic Measuring Instrument Arrangements

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	7	
Instrument air systems		1
Air supply regulators		
Supply pressures and signal ranges		1
Signal transmission piping		
Transmission lag		1
Process connections		
Instruments mounting		1
Basic measurement loops		
Temperature measuring channel		1
Pressure measuring channel		
Flow measuring channel		
Level measuring channel		1

		6

Block 8 - Pneumatic Control Instruments

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	8	
Two-position controller		1

Integral controller		
Proportional-plus-integral controller		1
Reset wind-up		
Proportional-plus-derivative controller		1
Proportional-plus-integral-plus-derivative controller		1
Fisher controls level-trol two-position controller		
Masoneilan 3706 proportional controller		1
Moore model 55 nullmatic proportional-plus-reset controller		1
Foxboro model 40 proportional-plus-derivative controller		
Taylor proportional-plus-reset-plus-rate controller		1

		7

Block 9 - Control Valves and Actuators

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	9	
Globe valves		1
Gate valves		
Checil valves		1
Butterfly valves		
Ball valves		1
Control valve actuators		
Diaphragm actuator		1
Piston actuators		
Electro-hydraulic actuators		1
Manual actuators		
Valve actuator selection		1
Control valve bodies and trim		
Single seated		1
Double seated		
Cage guided		1
Three-way		
Boot-style		1
Butterfly		
V-notch ball		1
Eccentric-disk		
Valve characteristics		1
Linear		
Quick-opening		1
Equal percentage		
Inherent and installed characteristics		1
Control valve selection		
Control valve sizing		1

Control valve noise		
Valve positioners		1
Fisher 3580 positioner		
Booster relays		1
Handwheels		
Snubbers		
Pneumatic lock-up valves		1

		17

Block 10 - Pneumatic Control Arrangements

<u>Topic</u>	<u>Chap</u>	<u>Hrs</u>
Introduction	10	
Basic control loop		1
Temperature control loop		
Pressure control loop		1
Flow control loop		
Level control loop		1
Cascade control		
Ratio control loop		1
Feedforward control loop		
Computer relays		
Foxboro model 136 summing junction		1

		5

TOTAL HRS = 72

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Specific Objectives

Block 1

The student shall be able to recall, explain or apply:

- 1) The force-motion relationship for; levers, pulleys, wheels and axles, inclined planes, screws and gears.
- 2) Mechanical advantage for above.
- 3) Types of gears.

Block 2

The student shall be able to recall, explain or apply:

- 1) Spring force-displacement relationship.
- 2) Types of beams and levers and applications.
- 3) Types of diaphragms and bellows and applications.
- 4) Types of link-lever mechanisms.
- 5) Angularity error and how it is eliminated.

Block 3

The student shall be able to recall, explain or apply:

- 1) The uses of a restriction.
- 2) Flapper nozzle detector for motion sensing.
- 3) The use of a pilot motion detector.
- 4) Pneumatic relay construction and types.

Block 4

The student shall be able to recall, explain or apply:

- 1) Characteristics of feedforward and feedback instruments.
- 2) The 5 possible functions performed by feedforward instruments.

Block 5

The student shall be able to recall, explain or apply:

- 1) Characteristics of angle and linear motion balance instruments.

Block 6

The student shall be able to recall, explain or apply:

- 1) How commercially available instruments use moment balance feedback, true force balance feedback, angle motion balance feedback and linear motion balance feedback to measure temperature, pressure, flow and level.

Block 7

The student shall be able to recall, explain or apply:

- 1) How clean dry plant air is made.
- 2) How it is distributed.
- 3) Standard instrument signal range.
- 5) Transmission lag.
- 6) Capacitance.
- 7) Correct installation of instrument sense lines.
- 8) Advantage and disadvantage of pedestal and line mounted instruments.

Block 8

The student shall be able to recall, explain or apply:

- 1) The characteristics and application for the following control actions:
 - a) On-off or two position
 - b) Integral
 - c) Proportional-plus-integral
 - d) Proportional-plus derivative
 - e) Proportional-plus-integral-plus-derivative
- 2) How these control actions are implemented in pneumatic controllers.

Block 9

The student shall be able to recall, explain or apply:

- 1) Characteristics and application of various types of control valves; globe, gate, check, butterfly and ball.
- 2) Types and characteristics of valve actuators.
- 3) The 3 common valve flow characteristics.

- 4) How to size a control valve using the valve coefficient.
- 5) Control valve noise.
- 6) Function and characteristics of common pneumatic valve positioners.
- 7) Purpose of booster relays, snubbers and pneumatic lock-up valves.

Block 10

The student shall be able to recall, explain or apply:

- 1) Construction of a pneumatic to electronic signal converter.
- 2) Construction of an electronic to pneumatic signal converter.