McGill University

Instrument Society of America

Course 660-220Y-71- Industrial Process Control and Automation

Coordinator: Leonard Pinchuk
Laboratory Instructor: Patrick Bouwman

1) ***Week one*** ***J.C LABELLE*** ***Jan 23***

Introduction to Automatic Control

What is a process? Why do we need to control a process? Types of Processes in industry. Types of automatic control systems. Difference between manual and automatic control. Relationship between sensing, measurement, decision and acting of a control system. Introduction to primary elements, controllers and final control elements. Introduction to process variables, measurement techniques, standards and engineering units.

2) ***Week two*** ***J.C LABELLE*** ***Jan 30***

Automatic Control Overview I

Types of sensors. Introduction to process variable transmitters and the purpose of transmitters. Types of transmitters and signals. Introduction to PID's and ISA symbols. Introduction to control theory. A global picture of the universal system sense-decide-act, translated into primary elements-controllers-final control elements. Introduction to the control modes and control functions.

3) ***Week three*** ***J.C LABELLE*** ***Feb 6***

Automatic Control Overview II

Analog and digital control. Different controller types; panel mounted, distributed control systems, analog control by programmable controllers. Descriptions of signal generation and measurement schemes: electrical and pneumatic.

4) ***Week four*** ***J.C LABELLE*** ***Feb 13***

Measurement of Primary Elements

Different types of pressure measuring devices. Selection of pressure transmitters for tough applications. Level measurement: types of material to gauge. Method of measurement level switches. Selection of level transmitters. Definition of heat. Heat measurement. Types of industrial thermometers. Principles of thermocouples. RTD;s, thermistors, thermal wells, radiation thermometry. Applications of temperature measurements. Selection of temperature transmission.

5) ***Week five*** ***J.C LABELLE*** ***Feb 20***

Automatic Control Theory

Proportional control, integral control, derivative control, offset, bias, ratio, PID control. Tuning and algorithm configuration and introduction. Time constant, dead time. Controller function, anatomy of a controller, pneumatic versus electric controller versus electronic controller.

6) ***Week six*** ***PIERRE BOUCHER*** ***Feb 27***

Flow Measurement I
Flow measurement overview: history, market share, manufacturers, and users. Fluid flow fundamentals: Reynold's & Bernouli's equations, basic gas law, Boyle's law, standard Vs actual velocity, profile, accuracy, overall system accuracy, repeatability, turndown, range ability, pressure/temperature/density/viscosity effects. Video presentation: Introduction to Industrial flow measurement.

7) ***Week seven*** ***PIERRE BOUCHER*** ***March 5***

Flow Measurement II
Flow meter types and classification. Discussion on head type devices (orifice, nozzle, venturi, pitot…), rotameters, vortex/swirl meters, turbine, magnetic, ultrasonic, positive displacement, mass and open channel flow measurement. Discussions covering: principle of operation, general construction, installation guidelines, sizing, advantages/disadvantages, and applications. Standard and practices. Comparison and selection.

8) ***Week eight*** ***SERGE BOLDUC*** ***March 12***

Analyzers
Different types of analyzers and the theory behind each one. Analyzers that do the measurement of density & specific gravity, viscosity oxygen, pH. thermal conductivity, dissolved oxygen and combustible measurement for safety are discussed. In addition, process chromatography are also covered as to hardware, sample handling systems, design and installation of analyzer systems, process analyzer calibration & maintenance and the performance and role of analyzers in process control.

9) ***Week nine*** ***LEONARD PINCHUK*** ***March 19***

MID TERM EVALUATION
COUNTS FOR 40% OF FINAL MARK

10) ***Week 10*** ***SERGE TRUDEL*** ***March 26***

Final Control Elements I
The purpose of final control elements. Types of final control elements: control valves, dampers, louvers, governors, metering pumps and variable speed feeders. Introduction to control valves and actuators, control valve functions. Different types of control valves: globe, ball & butterfly.

10A) Week 10 Saturday PATRICK BOUWMAN ***March 29***

Lab sessions ***OPTIONAL***

11) ***Week eleven*** ***SERGE TRUDEL*** ***April 2***

Final Control Elements II
Pressure classifications and valve shut off ratings. Valve body design. Control valve selection and sizing for water, oil, gas, air and steam. Noise in control valves; valve maintenance & diagnostics. Application: actuator selection and sizing.

12) ***Week 12*** ***PATRICK BOUWMAN*** ***April 9***

Batch Control and Ladder Diagrams
Discussion of relay logic originally used in process control. This concept is still used today even though the hardware has evolved. Sequential process steps in batch control. Development of sequential logic. Translating this.

13) ***Week thirteen*** ***PATRICK BOUWMAN*** ***April 16***

Programmable Controllers
Programmable controllers: detailed systems overview. Processors, memory, input/output modules. Sequential control and analog control. Programming: ladder diagrams and/or Boolean logic. Applications. Selection of PC's for specific applications. Communication with operator and process interface units.

14) ***Week fourteen*** ***PATRICK BOUWMAN*** ***April 23***

Computer Applications
Overview of computer hardware and software. Programs and files; window operating systems, user interface concepts. Types of software commonly used. Data communications and networks; Internet. Use of specialized computer software for integrated process description, management, and control. Special requirements of real-time computing.

15) ***Week fifteen*** ***PATRICK BOUWMAN*** ***April 30***

Distributed Control Systems

Evolution of control systems. Distributed control systems and hardware. System configurations. Additional hardware requirements: host computer, multiplexers, modems, etc. Data communications. Applications for distributed control systems. A functional overview, system security, software, fill-in-the-menu configuration. Control and tuning configurations, trending, alarms. Operator/Process interface systems. How to select the most economical operator for the size of your system.

15A) Week fifteen Saturday ***PATRICK BOUWMAN*** ***May 3***

Lab sessions ***OPTIONAL***

16) ***Week sixteen*** ***LEONARD PINCHUK*** ***May 7***

Course review
Review and over-view of instrumentation control technologies and strategies. Review of instrumentation applications of control systems and final control elements. Overview of control strategies and technologies. Overview of activities required for a process control and instrumentation project. Course summary and wrap up.

17) ***Week seventeen*** ***LEONARD PINCHUK*** ***May 14***

Final examination

Counts for 60% of final mark

This written evaluation will encompass all material covered throughout the course.

NB.

- While the questions for the final evaluation are formulated in the English language, it is the student's choice to answer in either the French or in the English language.

- The student's final course grade will be issued through McGill University.

- An attestation will be granted by McGill University and by the Instrument Society of America (ISA) Montreal Section, Inc. upon completion of the course.

- McGill University reserves the right to modify this course outline.