

Instrumentation and Automation Fundamentals

Introduction

Automation and control systems are an essential part of any industry, and, to an increasing degree, our domestic life. The manufacture of food products, chemicals, plastics, textiles, aircraft, wood and pulp products **all** require extensive use of automation and control systems to produce quality products in the most cost effective and environmentally safe manner. The increased availability of low cost “smart electronic” systems has precipitated an explosion in the development of *measurement* and *control systems* for application in both consumer products and industrial automation systems.

The modern automobile, for example, has an incredible number of sensors and microcomputers which are used to operate the vehicle in the safest and most efficient manner. There are sensors for measuring engine temperatures and pressures as well as flows of operating fluids such as oil and coolant. There can also be advanced applications such as the measurement of oxygen content in exhaust gas to adjust (via feedback) the air and fuel ratio for best possible combustion efficiency and minimum pollution.

Other more sophisticated measurement and control systems include ABS braking systems, optimized transmission shifting, traction control, multiple air bag sensors, and recently collision avoidance and self parking, etc.

Many domestic appliances now employ sensors and controllers to improve their convenience and performance. The microwave oven that automatically reheats food until a sensor detects a significant rise in the moisture content of the air inside the oven, is an example of automatic control not possible (at a reasonable price) a short time ago. In the home, consumers are constantly looking for ways of cutting energy costs and improving convenience. Manufacturers of consumer goods are responding with an ever-increasing supply of “smart” appliances and systems. Clothes dryers for example, no longer simply run on a time schedule, but can be set to run until the moisture content of the dryer exhaust air falls to a prescribed level (**clothes are dry!**). While the clothes are heated, a moisture sensor continuously measures the *relative dryness* of the exhaust air, which in turn **infers** or represents the dryness of the clothes. The dryer is then stopped, not by a timer, but when the feedback measurement of the dryness meets the requirements set by the user.

This is an example of a true, automatic (*feedback*) control system which measures an outcome (dryness) and makes corrective action in direct response to that outcome.

In the manufacturing and processing industries, automation and control systems are being used in every way possible to lower production cost, improve energy efficiency, reduce the carbon footprint, increase production capacity, enhance safety, reduce pollution and, last but not least, improve quality.

These nine introductory modules cover the *fundamental principles* or *basics* of industrial and commercial control systems.

Technological change is occurring at a rapid pace, as an example, observed with the latest *Smart Phones* with all their latest special features and capabilities.

It is reassuring to know that most of the measurement and control *fundamental principles don't change*.

The first 5 modules of this course deal with *principles* and application concepts of typical process measurement and control equipment.

Module 6 examines the *fundamental concepts* of the most common methods (*modes*) of control.

Module 7 covers the *basic principles* encountered in typical Final Control Elements.

Module 8 is an introduction to Industrial Data Communications and Networking. This module will provide an *overview* of the rapid changes taking place due to the application of digital devices and digital communications.

Module 9 is a glossary of common terminology used in the Automation and Instrumentation field.

Review Questions and Answers: Each Module above has a Review Exercise, with complete answers provided in the last section of this book.