

MECH 420 SENSORS AND ACTUATORS

Assignment 1

Problems 1.2, 1.3, 1.6, 1.7, 1.8, and 1.9 from the textbook

Problem 1 (Problem 1.2 from Textbook)

You are asked to design a control system to turn on lights in an art gallery at night, provided there are people inside the gallery. Explain a suitable control system, identifying the open-loop and feedback functions, if any, and describing the control system components.

Problem 2 (Problem 1.3 from Textbook)

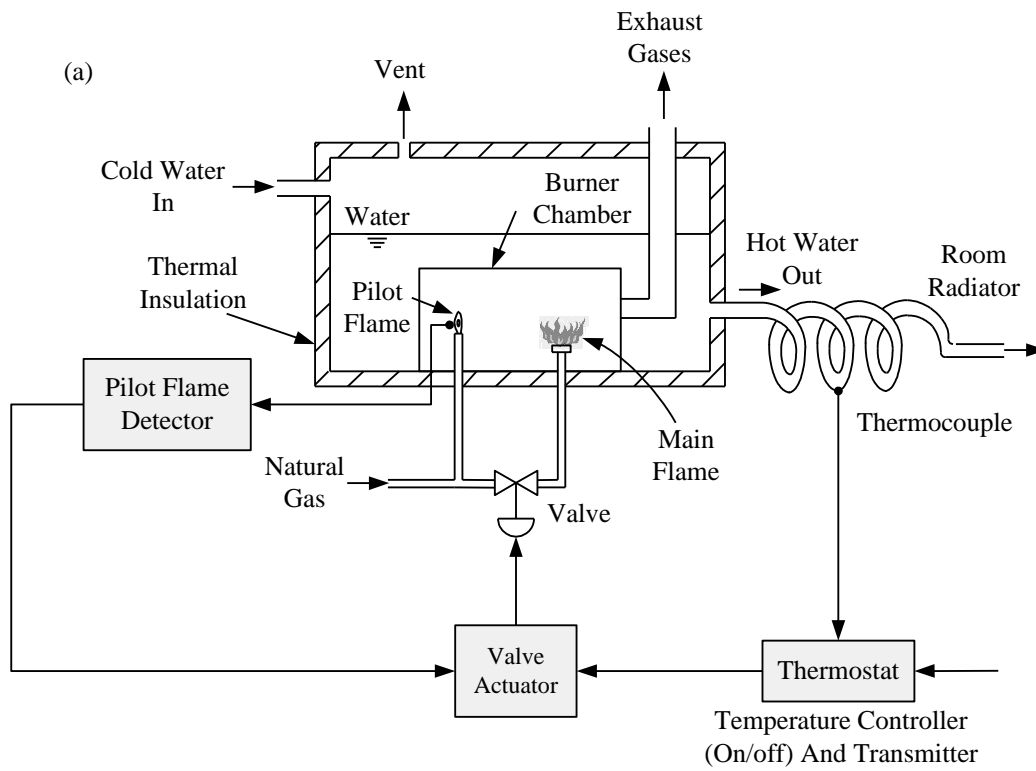
Into what classification of control system components: actuators, signal modification devices, controllers, and measuring devices would you put the following devices: Stepper motor, Proportional-plus-integration circuit, Power amplifier, ADC, DAC, Optical incremental encoder, Process computer, FFT analyzer, Digital signal processor (DSP).

Problem 3 (Problem 1.6 from Textbook)

A soft-drink bottling plant uses an automated bottle-filling system. Describe the operation of such a system, indicating various components in the control system and their functions. Typical components would include a conveyor belt; a motor for the conveyor, with start/stop controls; a measuring cylinder, with an inlet valve, an exit valve, and level sensors; valve actuators; and an alignment sensor for the bottle and the measuring cylinder.

Problem 4 (Problem 1.7 from Textbook)

Consider the natural gas home heating system shown in Figure 1.7. Describe the functions of various components in the system and classify them into the functional groups: controller, actuator, sensor, and signal modification device. Explain the operation of the overall system and suggest possible improvements to obtain more stable and accurate temperature control.



- (b)
- w_1 = Water flow rate
 w_2 = Temperature of cold water into furnace
 w_3 = Temperature outside the room

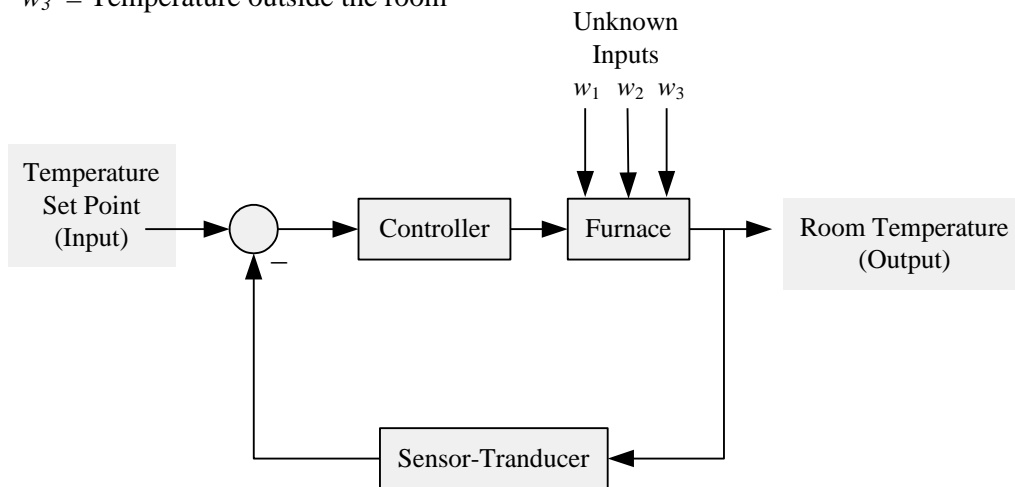


Figure 1.7: (a) A natural gas home heating system; (b) A block diagram representation of the system.

Problem 5 (Problem 1.8 from Textbook)

In each of the following examples, indicate at least one (unknown) input that should be measured and used for feedforward control to improve the accuracy of the control system.

- (a) A servo system for positioning a mechanical load. The servo motor is a field-controlled dc motor, with position feedback using the pulse count of an optical encoder and velocity feedback using the pulse rate from the encoder.
- (b) An electric heating system for a pipeline carrying liquid. The exit temperature of the liquid is measured using a thermocouple and is used to adjust the power of the heater.
- (c) A room heating system. Room temperature is measured and compared with the set point. If it is low, the valve of a steam radiator is opened; if it is high, the valve is shut.
- (d) An assembly robot that grips a delicate part to pick it up without damaging the part.
- (e) A welding robot that tracks the seam of a part to be welded.

Problem 6 (Problem 1.9 from Textbook)

A typical input variable is identified for each of the following examples of dynamic systems. Give at least one output variable for each system.

- (a) Human body: neuroelectric pulses
- (b) Company: information
- (c) Power plant: fuel rate
- (d) Automobile: steering wheel movement
- (e) Robot: voltage to joint motor.