Loughborough University

Control and Commissioning for Low Energy Buildings

23CVP307

Semester 2 2024 In-Person Exam Paper

This examination is to take place in-person at a central University venue under exam conditions. The standard length of time for this paper is **2 hours**.

You will not be able to leave the exam hall for the first 30 or final 15 minutes of your exam. Your invigilator will collect your exam paper when you have finished.

Help during the exam

Invigilators are not able to answer queries about the content of your exam paper. Instead, please make a note of your query in your answer script to be considered during the marking process.

If you feel unwell, please raise your hand so that an invigilator can assist you.

You may use a calculator for this exam. It must comply with the University's Calculator Policy for In-Person exams, in particular that it must not be able to transmit or receive information (e.g. mobile devices and smart watches are **not** allowed).

Answer **THREE** questions.

All questions carry equal marks.

Continues/…

1. a) Explain the functional hierarchy of a control system explaining the purpose of each level of control. Illustrate your answer with an example of the hierarchical structure of a building control system.

[10 marks]

b) Explain the causes of distance-velocity and transfer lag in building control systems, giving examples of each form of lag.

[8 marks]

c) Explain the phrase “negative feedback”, and its application to proportional control action.

[7 marks]

d) Figure Q1, illustrates the valve flow-opening characteristic of the same control valve when it is installed in two separate systems. Using the concept of valve authority, explain why the characteristic for the valve installed in system ‘B’ is more linear than when installed in system ‘A’.

[8 marks]

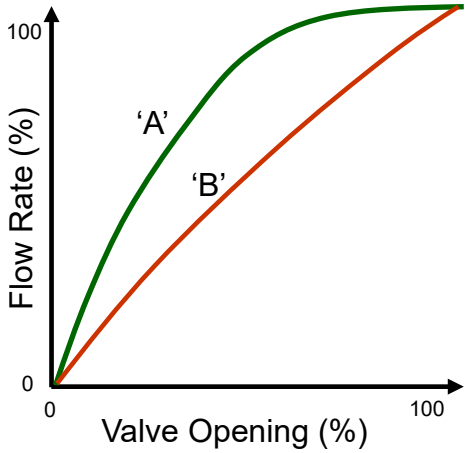

Figure Q1. Installed Valve Characteristic for Two Different Systems

2. a) Explain the purpose and operation of an optimum start controller used in the control of heating system start-times. Include a diagram in your answer to illustrate the relationship between, start-time, the change in internal temperature during periods in which the heating is OFF, and the impact of external temperature and the start time.

[8 marks]

b) A building manager notices that the control signals to the heating and cooling coils and the air mixing dampers of an air-handling unit are all set to 100% at the same time. Discuss why this operation is inefficient and propose a more efficient control strategy. Illustrate your answer with a diagram of the control sequence for heating, cooling, and air mixing.

[9 marks]

Question 2 continues/…

c) What four key outcomes does the commissioning process achieve?

[2 marks]

d) Name four systems that require commissioning in a building and state any relevant CIBSE commissioning codes in your answer.

[6 marks]

e) Discuss the main activities the commissioning process includes.

[8 marks]

3. (a) Clearly describe the structure and operation of an outstation controlling a hot-water cylinder and explain the input conversion of analogue to a digital signal.

[17 marks]

(b) Describe various elements of Building Energy Management Systems (BEMS) and briefly explain networks used for BEMS communications.

[16 marks]

4. (a) What features make natural ventilation more difficult to control than mechanical ventilation and why?

[6 marks]

(b) Describe the differences between ramp and step function control, giving your opinion on which is best for controlling natural ventilation.

[7 marks]

(c) In what situations is CO2-based control likely to be more appropriate than IAQ or temperature-based control and why?

[3 marks]

(d) Describe how you might commission and fine tune an innovative, mixed mode building.

[10 marks]

(e) How do you think control systems will need to change to minimise risk of transmission of Covid-19 in mechanically ventilated buildings?

[7 marks]

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