Loughborough University

Control and Commissioning for Low Energy Buildings

24CVP307

Semester 2 2025 | 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/…

Copyright © Loughborough University. All rights reserved.

1. (a) A sustained offset is observed between the air temperature leaving a heating coil and the temperature setpoint. Discuss the possible reasons for the offset and how it can be removed.

[7 marks]

(b) Explain the following characteristics of a sensor:

(i) gain;
(ii) linearity;
(iii) sensitivity;
(iv) accuracy;
(v) drift;
(vi) bias;
(vii time-constant.

[13 marks]

(c) Figure Q1 illustrates the ideal relationship between the output of a controller and the air temperature rise across a heating coil. Explain how the type of control valve and its authority can be selected to provide a near-linear relationship between controller output and air temperature rise across the coil. Illustrate your answer with diagrams showing the relationship between the water flow rate through the installed valve and valve opening, and between the water flow rate and air temperature rise.

[13 marks]

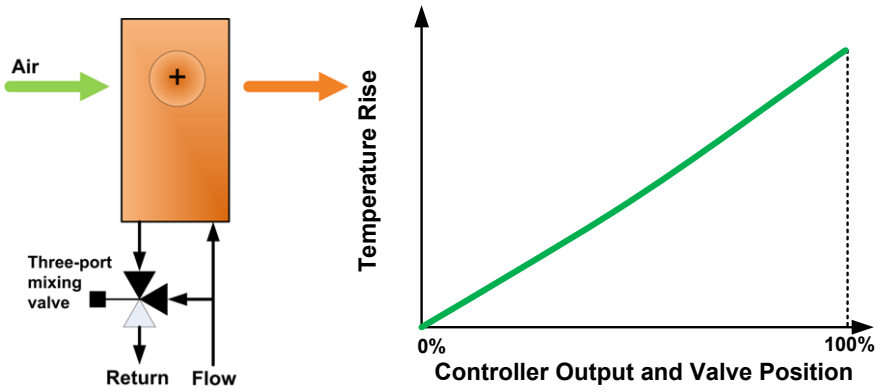


Figure Q1. Heating Coil Sub-system and Ideal Output Characteristic

Continues/…

Copyright © Loughborough University. All rights reserved.

…/continued

2. (a) Multiple boilers are commonly installed in large buildings. Explain how the number of boilers operated is controlled to match the heating demand of the buildings. Include a diagram that illustrates the heating system controller components and connections together with a table that defines the control sequence in your answer.

[10 marks]

(b) Explain the errors that can result from the use of a time-clock supervisor and why they can occur.

[6 marks]

(c) Imagine you are commissioning a Variable air Volume HVAC system that serves a single, large space. The system comprises of an Air Handling Unit with a heat exchanger, a heating and cooling coil and a supply and extract fan. The AHU is connected to the conditioned space by a network of ducts and controlled using a Building Energy Management system.

Discuss the sequence of system readiness and commissioning processes that will allow the systems to be commissioned in order to provide the desired conditions in the space. Describe the stages of the relevant commissioning processes and comment on factors that can affect the commissioning process.

[17 marks]

3. (a) Describe various elements of Building Energy Management Systems (BEMS) together with the structure of an outstation.

[17 marks]

(b) Briefly explain networks used for BEMS communications and advantages and disadvantages of BEMS systems.

[16 marks]

4. (a) Describe four characteristics of natural ventilation in non-domestic buildings that make it more difficult to control than mechanical ventilation?

[13 marks]

(b) Describe (in words) how a ramp function might be used to open windows in a naturally ventilated building based on CO2 control alone. Your answer must include values for any set points.

[7 marks]

(c) During commissioning, complete system performance checking involves global performance checks, system level checks and sub-system level checks. Give two examples for each of these three commissioning checks.

[9 marks]

(d) State two reasons why fine tuning is so important following commissioning.

[4 marks]

J Wright, R Buswell, M Eftekhari

Copyright © Loughborough University. All rights reserved.