Control and Commissioning for Low Energy Buildings
22CVP307

Semester 2 2023 Online Short-window Exam paper

This is an online short-window examination, meaning you have a total of **2 hours plus an additional 30 minutes** to complete and submit this paper. The additional 30 minutes are for downloading the paper and uploading your answers when you have finished. If you have extra time or rest breaks as part of a Reasonable Adjustment, you will have further additional time as indicated on your exam timetable.

It is your responsibility to submit your work by the deadline for this examination. You must make sure you leave yourself enough time to do so.

It is also your responsibility to check that you have submitted the correct file.

Exam Help
If you are experiencing difficulties in accessing or uploading files during the exam period, you should contact the Exam Helpline. For urgent queries please call **01509 222900**.

For other queries email examhelp@lboro.ac.uk

You may handwrite and/or word process your answers, as you see fit.

You may use a calculator for this exam.

Answer **THREE** questions.

All questions carry equal marks.

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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]

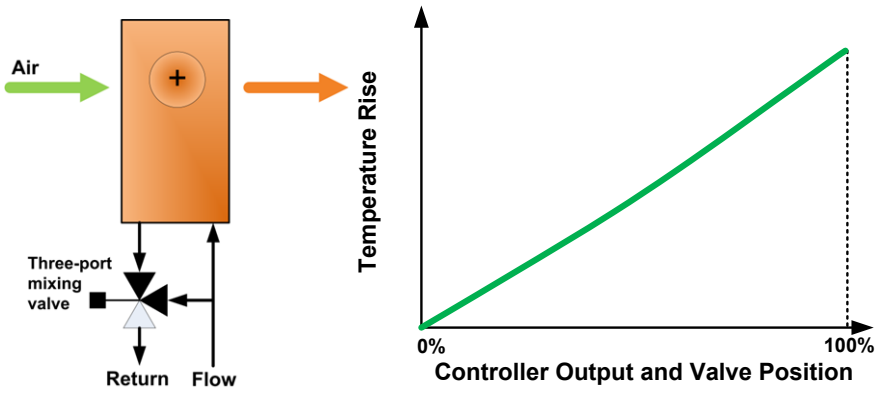

Figure Q1. Heating Coil Sub-system and Ideal Output Characteristic

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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) Define ‘commissioning’ and give a summary of the commissioning process from Design to the documentation of the installation. [8 marks]

   (d) Describe the reasons that newly installed hydronic pipework require flushing and cleaning. [3 marks]

   (e) Give 3 typical problems relating to commissioning and recommend solutions for each. [6 marks]

3. (a) Describe various elements of Building Energy Management systems (BEMS) and advantages and disadvantages of BEMS. [16 marks]

   (b) Briefly describe the operation of an outstation controlling a hot-water cylinder and explain the input conversion of analogue to a digital signal. [17 marks]

4. (a) It is often said that the control of buildings for natural ventilation is more Challenging than mechanical ventilation. Why is this? [8 marks]

   (b) How might a ramp function based control save energy compared with a step function based control? [6 marks]

   (c) Give three examples of how natural ventilation control might fail. [6 marks]

   (d) Why do you think it might be difficult to commission and fine tune an innovative, mixed mode building? [6 marks]

   (e) How do you think control systems will need to change to minimise risk of transmission of Covid-19 and similar viruses in mechanically ventilated buildings? [7 marks]

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