

## CONTROL AND COMMISSIONING FOR LOW ENERGY BUILDINGS (21CVP307)

Semester 2 2021-22

Online Short-window Exam paper

This is an online short-window examination, meaning you have a total of **2 hours plus 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](mailto: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 facilities manager is monitoring the control of a room temperature, and notices that there is sustained offset between the room temperature setpoint and the room air temperature.

- i) Give one possible reason for the offset.

[2 marks]

- ii) Specify a control mode that will operate to remove the offset and explain how the control mode removes the offset.

[6 marks]

Question 1 continues/...

.../question 1 continued

- (b) Using your own words, and with the aid of diagrams, define and explain the difference between the sensitivity, gain, and accuracy of a temperature sensor.  
[12 marks]
- (c) The air temperature leaving a heating coil is known to increase non-linearly with the water flow-rate through the coil. Explain, with the aid of diagrams, how a control-valve can be selected and installed to provide a linear increase in air temperature leaving the coil, with an increase in control signal and valve opening position.  
[13 marks]
2. (a) Control systems have two levels of control, supervisory control, and process control. Briefly explain the purpose of each level of control, giving examples of each.  
[5 marks]
- (b) Explain, using your own words, and with the aid of diagrams:
- i) The two forms of errors that can occur when starting operation of a heating system, and the effect that they have on occupant thermal comfort and heating energy use.  
[6 marks]
- ii) How an optimum-stat controller operates without start errors.  
[6 marks]
- (c) Explain the term 'static completion' as it relates to a pumped hydronic heating network, transferring heat from a gas fired boiler plant to heating coils in a central air handling unit and to heating coils in terminal units in fan coil units. Describe the commissioning process for such a system and comment on the sequencing of completion of systems to enable complete commissioning and final handover of systems as well as any other important factors to consider.  
[16 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]

Continues/...

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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 CO<sub>2</sub>-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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