Loughborough University

Net Zero Building Design
23CVP309

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) i) What is the main principle of the Passivhaus standard?

[2 marks]

ii) Compare the Passivhaus standard with general passive house approaches to building design, providing at least two ways in which these are similar and two ways in which they differ.

[4 marks]

b) Explain what is meant by the term “Active Building”, and comment on how this differs from other standards, such as Passivhaus.

[4 marks]

c) Comment on the role that could be played by Active Buildings in the future energy system. In your answer, consider intermittent renewable electricity generation, the use of on-site renewable generation, the limitations of the electricity distribution network and the electrification of heating and transport.

[8 marks]

d) Comment on the requirements for modelling Active Buildings, and how this could influence the preferred method of modelling these buildings.

[4 marks]

e) i) Which are the 5 steps in the UK Green Building Council’s (UKGBC) ‘Net Zero Carbon Buildings: A framework definition’ document?

[5 marks]

ii) With the framework in mind, how would you assess if a building can be considered Net Zero Carbon during its construction phase and during its operational phase?

[6 marks]

2. a) i) What is a building’s Base Temperature?

[2 marks]

ii) What are the Base Temperature values used by convention in the UK?

[2 marks]

b) Calculate the building’s Base Temperature in ^{o}C, for a desired indoor air temperature of 20^{o}C, total solar and internal gains of 800W and a heat transfer coefficient of 2166W/K.

[8 marks]

Question 2 continues/…

c) i) What is a ‘fabric first’ approach to building design?

[2 marks]

ii) Thinking critically about the building design hierarchy, justify in what ways a fabric first approach can be beneficial.

[6 marks]

d) i) Using a graph, demonstrate the impact of high and low thermal mass in the indoor air temperature of a building over 48hours and in relation to the external air temperature.

[7 marks]

ii) Provide a critical evaluation of the role of high thermal mass in warmer external conditions.

[6 marks]

3. a) Explain why ventilation is important for building occupants.

[3 marks]

b) Natural ventilation is an environmentally friendly alternative to mechanical ventilation. Describe how buoyancy-driven natural ventilation can be used to cool and ventilate a building.

[5 marks]

c) What are the disadvantages for natural ventilation as compared to mechanical ventilation?

[5 marks]

d) When designing for natural ventilation, it is important to incorporate additional passive design measures. Give four such measures and explain briefly how they can support the natural ventilation system.

[8 marks]

e) Describe the mixed-mode ventilation and cooling strategy employed in the building used by the School of Slavonic and East European Studies.

[7 marks]

f) Explain how the combination of control and thermal mass was used in the library at Coventry University to maintain thermally comfortable conditions.

[5 marks]

Continues/…

4. a) Describe what ‘electrochromic glazing’ is, and comment on why it has gained acceptance globally.

[3 marks]

b) What is Climate-based Daylight Modelling (CDBM)? Provide four benefits of CDBM. Discuss what the limitations are of using the alternative method of Daylight Factors.

[10 marks]

c) Consider a rectangular room, with one window and one door. Assume that the door has the same paint finish as the walls. The window glass is set back in a reveal, and there is some obstruction, with an angle θ subtended by sky visible from the centre of the window. The characteristics found in Table 1 describe the room.

Table 1. Room geometry details and building element characteristics

Characteristic	Value
Room Width	5m
Room Depth	9m
Floor to Ceiling Height	3m
Window Width	3m
Window Height	2m
Window Transmittance (T)	0.71
Maintenance Factor (M)	0.9
Wall Paint Reflectivity	0.62
Ceiling Paint Reflectivity	0.75
Floor Covering Reflectivity	0.25
Window Reflectivity	0.1
Angle of Sky Obstruction (θ)	65°

i) Using the above information, calculate the Average Daylight Factor (ADF) in the space.

[16 marks]

ii) Based on the calculated ADF figure, conclude on whether the level of lighting in the space is adequate.

[4 marks]

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