Loughborough University

Wellbeing and Indoor Environment
23CVP302

Semester 1 2023-24 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) Humans are homeotherms. Describe the meaning of the term homeotherm and the associated human thermoregulatory response to changing thermal environments.
[7 marks]

b) It is a common belief that human thermal comfort is dependent on dry bulb temperature alone. Explain why this is a misconception and discuss the importance of other factors that influence thermal comfort.
[6 marks]

c) Explain the concept of adaptive thermal comfort and how it is evaluated in thermally "free running" buildings. Illustrate your answer with a diagram which shows the adaption to changes in ambient temperature.
[10 marks]

d) Ole Fanger developed two indices that together define the probable thermal sensation and comfort of building occupants in air-conditioned buildings. Define and discuss the indices and the relationship between them.
[10 marks]

2 a) Explain the meaning of "indoor air quality" and how it is controlled.
[7 marks]

b) Discuss five sources of indoor air contamination and their potential effect on occupant health.
[10 marks]

c) Discuss the most common criteria for setting acceptable level of indoor air quality.
[6 marks]

d) Figure Q2d, shows the profile of CO_2 levels in a lecture room that has 10 occupants. If the outdoor air contains CO_2 at 410 ppm, and each occupant generates 5.0 cm^3/s of CO_2, calculate:

i) The ventilation rate in l/s. [5 marks]

ii) The ventilation rate in air changes per hour. [5 marks]

Question 2 continues/…

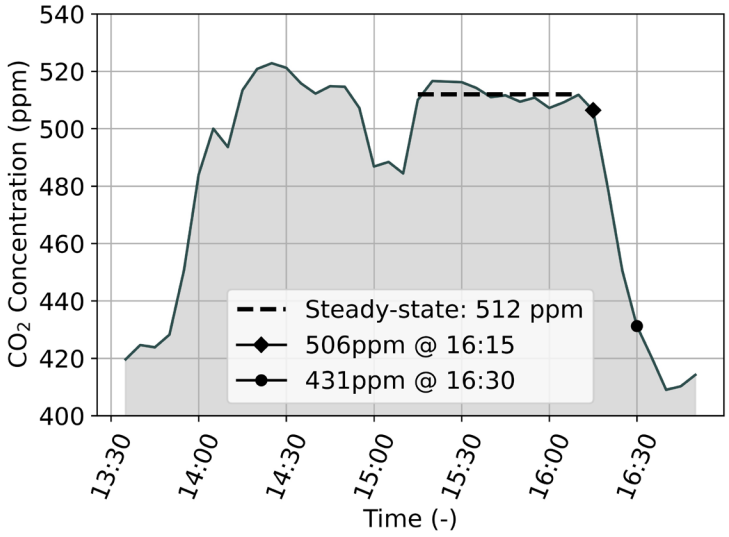

Figure Q2d, CO2 Levels in a Lecture Room

Note that full marks will only be awarded where the principles and equations used in the calculations are included as part of the answer.

3 a) Explain the term 'Global Solar Ultraviolet Index -UV Index' and explain the reason behind its introduction by the World Health Organization (WHO). Give the values used in the current version of the index in your answer.

[4 marks]

b) Access to courtyard gardens and other similar amenities could offer positive health outcomes. Discuss why contemporary healthcare facilities are increasingly being designed with courtyards and other similar amenities.

[4 marks]

c) Explain the term 'daylight factor' and define all symbols used in the DF equation below. Explain the properties of the daylight factor including the limitations associated with applying it as a method to quality daylighting conditions in buildings.

[10 marks]

$$\overline{DF} = \frac{TW\theta M}{A\left(1 - R^2\right)}$$

d) Define what is meant by the term 'overheating' and list the most common types of rigid screens used in buildings.

[5 marks]

e) The benefits of using daylighting in buildings are numerous, yet they could be described under three to four core aspects. Describe the core benefits of using of daylighting in buildings.

[10 marks]

Continues/…

4 a) Describe anatomy of the middle ear together with the role that it plays in hearing. [8 marks]

b) Explain what the A-weighting measurement represents and its use and limitations in measuring the sound level in buildings. [6 marks]

c) There are two types of acoustic test room, and anechoic chamber and a reverberation chamber:

i) Define the reverberation time of a room. [3 marks]

ii) Explanation how the reverberation time in an anechoic chamber is different to a reverberation chamber, and how this difference is achieved. [4 marks]

d) A noise source is positioned in the corner of a room and emits sound energy at a rate of 0.006 W. The room is 5.0m wide by 4.0m long and has a height of 3.0m. If (at a particular frequency), the average sound absorption coefficient for the room is 0.55, calculate:

i) The sound power level at the speaker. [2 marks]
ii) The directivity factor, Q, for the speaker. [2 marks]
iii) The room constant, R. [3 marks]
iv) The direct sound pressure level 2.5m from the noise source. [2 marks]
v) The reverberant sound pressure level. [3 marks]

Note that full marks will only be awarded where the equations used in the calculations are included as part of the answer.

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