Loughborough University

Building Science
22CVA058

Semester 2 2023 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 **ONE** question from each of the **Sections A, B and C.**

All questions carry equal marks.

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SECTION A

(Answer **ONE** question from this section)

1. a) There has been a debate about climate change and the contribution of human activities to global warming. While climate change is complex, human influence can be explained as a series of steps. Explain with the aid of steps the relationship between human activities and climate change. [12 marks]

   b) The building sector is among the most energy-consuming sectors in the UK but also has the highest potential for energy efficiency. To 'optimize the energy use' of buildings, the Whole Building Design Guide (WBDG) committee recommend applying 'a comprehensive, integrated approach' to the design process. Explain why it is important to apply this process. Include five of the aims stated in the Guide in your response. [10 marks]

   c) Explain what is meant by 'ecological footprint' and what it measures. [5 marks]

   d) Windows are essential building elements. List their main functions. [6 marks]

2. a) Explain the term 'vernacular architecture' and its main characteristics. [5 marks]

   b) Chapter one of Hassan Fathy's pioneering book 'natural energy and vernacular architecture' explains the 'Effect of Climate on Architectural Form' in different regions and climates. Briefly discuss some of the effects explained in the above section on the vernacular architecture of hot regions such as Egypt and India in terms of window design and shading. [10 marks]

   c) 'Mashrabiyas' were common in certain climatic zones. Explain what was originally meant by the term, its current use and its main functions. [13 marks]

   d) Explain what is meant by the 'Malqaf' or 'Wind-catch' and discuss the main feature that specifies the 'Badgir' from the 'Malqaf'. [5 marks]

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SECTION B

(Answer **ONE** question from this section)

3. a) Explain with the aid of a diagram the components of natural light. [6 marks]

b) The term ‘daylighting’ is different from ‘daylight’. Give a definition for daylighting and list four architectural aspects that affect daylighting in buildings. [5 marks]

c) Figure Q3 shows a section for a proposed office space located in a building in the UK. Using a common rule of thumb comment on whether you consider the proposed depth (9 metres) acceptable for maintaining good daylighting levels at the rear of the room. [3 marks]

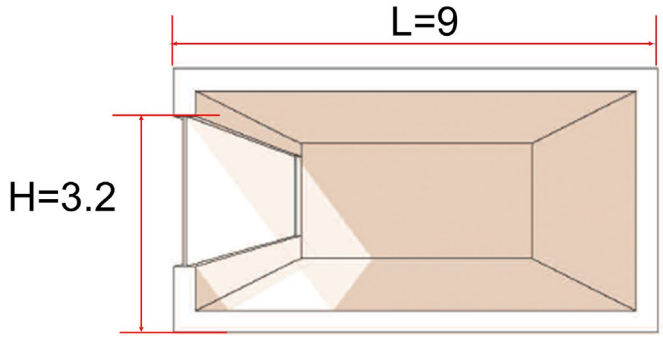

Figure Q3: section of the office space (measurements are in metres)

d) The given section (Figure Q3) shows a certain daylighting design strategy; describe the four possible sidelit design strategies used in building. [8 marks]

e) The following formula could be used to calculate the average daylight factor for a simple space. Explain the term daylight factor and define all symbols in the above formula.

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

[11 marks]

4. 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. [13 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. [10 marks]

c) Explain why vitamin D is traditionally termed the ‘sunshine vitamin’. [5 marks]

d) Several cultural and environmental factors have been recently found contributing to the high prevalence rate of vitamin D deficiency among some populations residing in sunny regions, list five of them. [5 marks]

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SECTION C

(Answer **ONE** question from this section)

5. a) A reference to the role of ‘shade’ as a physical protective measure is given in the Global Solar UV Index Practical Guide, as an ‘urban necessity’ in the face of the increasing events of heatwaves. What are the two actions stated in the report. [6 marks]

   b) List the most common types of rigid screens used in buildings. [5 marks]

   c) The provision of acceptable indoor air quality is part of the design requirements of buildings. Discuss why it is important to ventilate buildings with regard to human needs. [5 marks]

   d) Describe the monthly degree day approach and explain the difference between ‘Heating’ degree days and ‘Cooling’ degree days. Discuss the base temperatures that are often used in the UK for the degree day calculations. and explain the reasons for using these base temperatures. [17 marks]

6. a) Describe the difference between the Passivhaus standard and passive design measures. Describe which passive design measures are incorporated into the Passivhaus standard and how a Passivhaus-compliant house differs from a house that incorporates Passive design measures. [10 marks]

   b) List five issues and limitations associated with the Passivhaus standard. [5 marks]

   c) Reflecting on your experiences of using Sefaria, describe the term “performance-based modelling “and provide reasons as to why it’s carried out. Describe how a designer may prepare a model to carry out an evaluation in terms of energy use and daylighting. [8 marks]

   d) Sketch the energy design hierarchy framework highlighting each stage. Provide a brief explanation for each stage. [5 marks]

   e) Many cities such as London and New York have devised plans to become sustainable cities. List five features of a sustainable city. [5 marks]

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