Loughborough University

Low Energy Building Design
22CVP309

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) Using sketch, explain the 'balanced ventilation' principle used in Passivhaus mechanical ventilation system design. Explain the purpose of the three different zones when using Mechanical Ventilation with Heat Recover (MVHR). [13 marks]

   b) List eight typical rooms found in a domestic dwelling and for each room indicate its typical ventilation zone classification. [8 marks]

   c) Explain the six main design principles used in Passivhaus design and their limiting values (where appropriate). [12 marks]

2. a) What are TRY & DSY weather files, and explain their purpose? [4 marks]

   b) What is a performance gap? [2 marks]

   c) What are the common causes of the underperformance of buildings? [9 marks]

   d) A building design (optimization) problem can be defined by the design objectives, design constraints, and design variables. A client approaches you to design a low carbon building, and to use optimization in this process. Explain how you would set up three objectives, three constraints and three variables to assess the optimal performance trade-offs. [9 marks]

   e) Explain how the design of buildings must adapt to climate change. Use the example of a new office building in London and consider how it could be adapted to keep cool, keep dry and keep warm. [9 marks]

3. a) With the aid of a diagram and/or graphs, explain the theory underpinning buoyancy-driven natural ventilation. You may use equations to support your answer. [9 marks]

   b) The Lanchester library in Coventry is a large naturally ventilated building. Explain why high ceilings, thermal mass and solar shading are so important to the success of the ventilation strategy. [7 marks]

   c) Describe how a subterranean labyrinth can be integrated into a passive cooling and ventilation strategy. [4 marks]

   d) i) What are the benefits of mixed mode ventilation and what sort of buildings and locations will benefit from this strategy? [5 marks]

      ii) What technique could you use to determine whether a location is suitable for mixed mode ventilation? [4 marks]

   e) By describing the principles of passive downdraught evaporative cooling, why might it be difficult to employ this technique in hot humid climates? [4 marks]

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4. a) List four reasons as to why daylighting is needed and essential for occupants and buildings. [4 marks]

   b) The Useful Daylight illuminance metric (UDI) is a metric based on the human factors. The UDI specifies three main levels where the UDI falls short, where it is achieved and where it is exceeded. Show the classification of each stage in Lux (Unit). [4 marks]

   c) Explain what is meant by climate-based daylight modelling, and why was it regarded as a better alternative to the daylight factor methodology? [10 marks]

   d) Consider a room 6 m wide, 9 m deep with a floor to ceiling height of 3 m and a single window 4 m wide and 2 m high in one of the walls. The window transmittance T = 0.68 and the maintenance factor M is 0.8. The paint on the walls has a reflectivity ρ = 0.65 (i.e. 65%) and the ceiling paint finish has a reflectivity ρ = 0.75. The reflectivity of the window can be assumed as ρ = 0.1. The floor covering has a reflectivity ρ = 0.25. Assume that the door (which is in one of the walls) has the same paint finish as the walls. The window glass is set back in a reveal, and there is some obstruction with the angle θ subtended by sky visible from the centre of a window is 55°.

   Calculate the average daylight factor (ADF) in the space using the above information. [15 marks]

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