

Exam : Design of sustainable energy systems for the built environment
Code : 7S815

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- Number every page and put your id-number and name on it.
- Papers, readers, etc. are **NOT** allowed to be used.
 - This exam consists of 5 topic-questions. Each question has three or four sub questions.
 - Each sub question scores a maximum of 10 points. Final score for this exam is arrived at through averaging the scores over the 17 sub questions.
 - Topic-questions can be answered independently of each other.
 - Answer each question completely and thoroughly but only include relevant information.
 - This exam consists of two pages.
 - Answers can only be given in English.
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1. Topic: Peak oil, Integrated design and design strategies

- a) What is the 'peak' problem as identified by Hubbert and discuss its relevance for the built environment.
- b) Describe 'Trias Energetica' and provide for each basic building design strategy that is covered by 'Trias Energetica' at least two (2) concrete examples.
- c) Mention at least four (4) different topics that should be considered when designing a sustainable building and explain why they should be considered. In addition, indicate for each topic mentioned to which value domain it belongs. Make sure that the topics mentioned together cover at least three (3) value domains.

2. Topic: Thermal energy storage systems

- a) Explain why heavy constructed buildings have a slower thermal response, and how this helps in reducing the peak capacity of the cooling system.
- b) Explain how in light constructed buildings PCM materials can compensate for the lack of 'thermal mass'.
- c) Why are chemical storage systems based on adsorption of absorption technology better suited for long-term storage than systems based on sensible or latent heat?
- d) Give an application of a diurnal storage for buildings, and explain how it can help reducing the use of fossil energy.

Topic-questions 3, 4 and 5 on next page

3. Topic: Passive design

- a) Give an overview of the main three different façade designs that can be identified. Draw these façade systems and describe their advantages and disadvantages in relation to energy consumption and comfort for application in a hot tropical climate (high outdoor temperature, high relative humidity) and provide your preference for this location based on these descriptions.
- b) For a dwelling located in the Netherlands, discuss the preference for orientation and window-to-wall ratio (use of solar gain) or for better insulation, when designing the dwelling for a low heating energy demand in winter time.
- c) If you design a standard office and sustainability is of importance, which of the three main ventilation strategies is best applied for a moderate climate such as found in the Netherlands and why? (include in your argumentation not only energy use)

4. Topic: Heating & Cooling

- a) Explain the principle of direct adiabatic cooling, en give the climate conditions for optimal performance.
- b) Explain why 'high' temperature cooling and 'low' temperature heating affects the performance of heat pump/cooler positively.
- c) Why is a heat pump well suited for heating of buildings; and give the other required components for successful application.
- d) Explain why an absorption cooler of 200kW cooling capacity needs a larger cooling tower than an electrically driven compression heat pump of 200kW.

5. Topic: Terminal systems

- a) Which three types of terminal systems can be distinguished? Mention these three types and provide for each type at least two representative example technologies.
- b) The percentage of people dissatisfied with respect to draught (PD_{draught}) is one of the performance indicators that are available in standards to assess thermal comfort conditions in a building. Mention at least three (3) other performance indicators with respect to thermal comfort and explain why the draught model as provided in the standards may not support the design of sustainable buildings.
- c) You are designing a meeting room for maximum 50 persons with changing occupancy throughout the day. Which type of terminal system would you propose to apply in this design and why?