UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualification:-

M.Sc.

Natural and Mechanical Ventilation in Buildings

COURSE CODE	:	**BENVEE04**
DATE	:	**05-MAY-06**
TIME	:	**14.30**
TIME ALLOWED	:	**2 Hours**

06-C0138-3-50

TURN OVER

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MSc DEGREE in SCIENCE in BUILT ENVIRONMENT 2006

Module BEN VE E04: NATURAL AND MECHANICAL VENTILATION IN BUILDINGS

Answer TWO questions only. Answer all parts of the questions chosen.

1. (a) An office building has a central open plan area of 40 by 15 m. If the density of occupation is 1 person per 10 m^2, and the fresh air ventilation rate required to maintain good air quality, is 8 litres per second per person, calculate the total volumetric flow rate necessary for the whole space (in m^3/s). If the floor to ceiling height is 3 m, what air change rate per hour is this equivalent to? (*5 marks*)

   (b) What issues would you need to take into consideration to ensure that this ventilation rate could be achieved in winter by passive means, without compromising the occupants' thermal comfort and without unnecessary waste of heating energy? (*10 marks*)

   (c) The fresh air rate of 8 litres per second per person is designed to maintain good air quality. Explain what is meant by good air quality in the context of an office building. (*5 marks*)

   (d) If the total heat gains to the space, mentioned in part (a) are 40 W/m^2, by how many degrees celsius would you expect the office space to be hotter than outside, with the ventilation rate of 8 litres per second per person? Assume the specific heat capacity and density of air to be 1.02 kJ/kgK and 1.12 kg/m^3 respectively, and ignore heat transfer through the fabric of the building. (*10 marks*)

   (e) What ventilation rate, in m^3/s, would you need to limit internal temperature to a maximum of 4 K above the outdoor temperature, with 40 W/m^2 total heat gain? What is this ventilation rate expressed in air changes per hour? (*5 marks*)

   (f) Discuss whether you feel that this ventilation rate could be achieved purely by ventilation from the windows in summer, and outline what you consider to be the critical factors in ensuring that this, and perhaps even higher, ventilation rates could be achieved. (*10 marks*)

   (g) Discuss what the environmental advantages of increasing the floor to ceiling height of the space might be. (*5 marks*)

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2. (a) High "thermal mass" buildings combined with "night ventilation" are often said to provide cooler indoor temperatures the following day than "lightweight buildings" sealed at night. Explain the meaning of "thermal mass", "lightweight buildings" and "night ventilation". Explain the principles of how thermal mass with night ventilation can produce this "cooling effect" in buildings. (*10 marks*)

   (b) Discuss the main principles, relating to the shape and layout of a non-domestic building, that promotes appropriate natural ventilation to help prevent overheating in summer. (*15 marks*)

   (c) What are the main heat loads on buildings that cause them to overheat in summer, and how can their impact be reduced? (*5 marks*)

   (d) Explain the importance of occupant behaviour in naturally ventilated non-domestic buildings in the success or failure of preventing overheating in summer. (*5 marks*)

   (e) Describe briefly a building you know well, or have studied extensively, which has attempted to use the principles of "thermal mass and night ventilation", either passively or with the assistance of fans but without using mechanical cooling, to reduce internal day time temperatures. Explain in more detail where the design was successful and why, and where it failed to deliver the expected cooling effect and why. (*15 marks*)

3. A university has decided to demolish an existing building and to build a new one in its place. The new building will face a very busy road and will form a typical urban street canyon with other surrounding buildings. The main facade will be at the leeward side of the canyon. In addition to 28 small seminar rooms, a set of 4 chemical laboratories and 3 large computer rooms will be located on the top two floors of the new building. The university is keen to keep the costs of the new development to a minimum. Taking this into account, discuss the following questions:

   (a) In designing any ventilation system it is necessary to understand the functions required of it. What do you consider to be the most important attributes of a ventilation system designed for the new building described above? (*10 marks*)

   (b) The challenge for building ventilation is to assist in the provision of good indoor environmental quality on a year round basis, while at the same time minimising energy use, carbon dioxide emissions and life cycle cost. In this context, discuss the main factors for and against implementation of a full mechanical ventilation system for the proposed building. (*15 marks*)

   (c) You have been asked to select and briefly present a ventilation strategy for the proposed building. What additional information would you need (and why) to carry out this work? (*15 marks*)

   (d) What factors would you take into account when locating air intake and discharge points? Discuss measures that you would consider to minimise re-entry of contaminated air from the chemical laboratories back into the mechanical ventilation system. (*10 marks*)

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4. Address the following questions in relation to air distribution in rooms and air filtration:

   (a) The effectiveness of all ventilation systems depends on the method by which supply air is introduced to and removed from the room. What are the most important parameters that influence the quality of the air at any point in the room? (*5 marks*)

   (b) ISO 3258 gives definitions and standard terminology used in connection with air movement. Define the following parameters (*5 marks*):

      i) throw
      ii) spread
      iii) drop.

   (c) What is the Coanda effect? (*5 marks*)

   (d) Discuss the factors which affect the selection of air distribution systems. (*5 marks*)

   (e) The positioning of the extracts has little influence on the air flow pattern in rooms. Why? (*5 marks*)

   (f) Explain the consequences for thermal comfort and air quality in a room if the position of the supply diffusers is wrong for the application. (*5 marks*)

   (g) In a building with mechanical ventilation, explain the "age of air" concept. (*5 marks*)

   (h) Explain why the fresh air supplied by a mechanical ventilation system is almost always filtered. (*5 marks*)

   (i) Discuss the energy implications of filtering air in mechanical ventilation and air conditioning systems. (*5 marks*)

   (j) Which tests have to be undertaken if a filter is to be classified as a fine dust filter? (*5 marks*)

END OF PAPER