UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualification:-

M.Sc.

ESGE5: Natural and Mechanical Ventilation in Buildings

COURSE CODE	:	**ENVSGE05**
DATE	:	**07-MAY-04**
TIME	:	**14.30**
TIME ALLOWED	:	**2 Hours**

TURN OVER

UNIVERSITY OF LONDON

MSc DEGREE in SCIENCE in BUILT ENVIRONMENT 2004

for Internal Students of University College London

Module ENVS GE 05: NATURAL AND MECHANICAL VENTILATION IN BUILDINGS

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

1. A school is about to build a new assembly hall, which will be used daily by the 500 students for a 15 minute morning assembly. It will also serve as a sports hall during some afternoons of the week, and provide a performance space for the school's music and drama societies, with rehearsals in the late afternoon, and some performances at night. The school is on an open suburban site in London, where there is little noise and air pollution. The school wants the new hall to be as "sustainable" as possible, and so wants it to use a minimum of fossil fuel for ventilation, heating and cooling. They are particularly concerned about how to provide good air quality for the large number of occupants that could be present at times, and about minimising overheating. Air conditioning has already been rejected.

   (a) Given the varied uses to which the hall will be put, the various times at which it will be used and the various lengths of time it will be used for, discuss the opportunities and problems that naturally ventilating it would raise. Assume that heating in winter will be provided by a perimeter radiator, or finned tube, hot water system. (*20 marks*)

   (b) The architect is proposing a fully mechanically ventilated solution for both summer and winter. Discuss what controls would be necessary to limit excessive energy consumption for the fan and for heating the outdoor air in winter. Comment on the thermal comfort that might be provided by this arrangement, for the various activities, on both cold winter and hot summer days. (*15 marks*)

   (c) It is finally decided to use a seasonal mixed mode arrangement. Explain the concept, and discuss how it might be made to work for the various activities, which will take place in the hall. (*15 marks*)

2. (a) An office building in London, with a total floor area of 500 m^2 and a floor-to-ceiling height of 3 m, has an occupancy density of 1 person per 10 m^2 of floor area and is required to have a fresh air ventilation rate of 8 litres per second per person. Calculate the volumetric flow rate (in m^3/s) of outside air that would be required to meet this requirement. What air change rate per hour does this represent? (*5 marks*)

(b) If the internal heat gains (from sun, occupants, lights and machines) in this building are 25 watts per square metre of floor area, by how many degrees celsius will the internal temperature be hotter than the external, if it is being ventilated with outdoor air at 8 l/s.person? Assume that the specific heat capacity of the air is 1026 W/kg.K and that the density of the air is 1.12 kg/m^3. Comment on your result. (*10 marks*)

(c) If you wish to maintain the internal temperature at no more than a maximum of 4°C above the external temperature, what air change rate per hour would you need to maintain in the building? (*5 marks*)

(d) The designer is concerned that it will be difficult to maintain this air change rate on calm days in summer, so a mechanical ventilation system is to be installed? If this system has a fan total pressure of 300 Pa, calculate the air power required to operate the ventilation system. If the efficiency of the fan is 70%, what is the fan power required? (*10 marks*)

(e) If the fan runs continuously from 8:00 am until 6:00 pm, 7 days a week, from the beginning of July to the middle of September, calculate how much it will cost to run the fan over this period, if electricity costs 7 pence per kWh. (*5 marks*)

(f) It is decided that maintaining a temperature of 4°C above outdoors would be unacceptable in the hottest months of the year, so it is decided to double the ventilation rate in order to maintain a temperature 2°C above outdoors. The fan is set to run from 1:00 pm to 6:00 pm each day at a higher speed during the summer months, as in part (e), to achieve the higher air change rate. If the fan total pressure increases to 450 Pa, and the overall fan efficiency drops to 65%, what additional cost would be incurred. (*10 marks*)

(g) Comment on why the fan total pressure increases when the ventilation rate increases. (*5 marks*)

3. (a) There has been considerable development in the design of naturally ventilated buildings, and of buildings using "mixed mode" or "hybrid" systems, in the UK over the last decade or so. These buildings attempt to reduce their reliance on active systems to control the internal thermal environment. Some have been extensively monitored and written up in the press. Select one that you know well, or have studied in detail, and, using sketches and diagrams to illustrate your answer, describe the concept behind the ventilation system, highlighting how the energy consumed by the building has been reduced by this system. Highlight what effect this ventilation arrangement has had on the form of the building. (*30 marks*)

(b) Approved Document F (Ventilation) of the current UK Building Regulations for Domestic Buildings refers to "rapid", "background" and "extract" ventilation. Explain the meaning of these terms, and explain why each is important. (*10 marks*)

(c) Explain the concept behind a passive stack ventilation system, as might be applied to a domestic kitchen or bathroom. Discuss the advantages and drawbacks of this type of ventilation arrangement. (*10 marks*)

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4. (a) In the context of a mechanical ventilation system, supplying fresh cooled air to a building, explain the "age-of-air" concept. (*5 marks*)

(b) In this same context, explain what is meant by "perfect piston flow", "perfectly mixed flow" and "non-ideal mixed flow with short circuiting and stagnant areas". Which of these three types of air distribution gives the lowest room-average age-of-air? What are the benefits to the occupants of this type of air distribution, and how might an engineer attempt to set it up in a real building? (*15 marks*)

(c) In a conventionally air conditioned building, explain the meaning of "mixing zone", "occupied zone", "throw", "spread" and "Coanda Effect". (*10 marks*)

(d) In too many air conditioned buildings, the selection, sizing and location of air supply points are wrong? What are the consequences for the occupants of the buildings? (*10 marks*)

(e) With regard to the air extract points in an air conditioned room, where would you avoid locating them? Why? (*10 marks*)

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