UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications:–

Eng.D. *M.Sc.*

ESGE5: Natural and Mechanical Ventilation in Buildings

COURSE CODE	:	**ENVSGE05**
DATE	:	**06–MAY–05**
TIME	:	**14.30**
TIME ALLOWED	:	**2 Hours**

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UNIVERSITY OF LONDON

MSc DEGREE in SCIENCE in BUILT ENVIRONMENT 2005

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) Discuss the statement "high thermal mass buildings in the UK carry energy and environmental benefits". (*15 marks*)

   (b) What factors contribute to overheating in buildings in summer. (*5 marks*)

   (c) Discuss how a building designer can alleviate summer overheating in naturally ventilated buildings in the UK, without compromising the energy performance of the building in winter. (*10 marks*)

   (d) Describe the factors in the ***operation*** of naturally ventilated buildings in the UK which can help alleviate overheating in summer. (*5 marks*)

   (e) Identify a naturally ventilated or mixed mode building you have studied or know well. Briefly discuss the methods it uses to control summer overheating, and highlight any factors that have been particularly successful, and that could be applied to other similar new buildings with advantage. (*15 marks*)

2. (a) Discuss the difference between air infiltration and natural ventilation in buildings, and distinguish between rapid and background ventilation. Discuss the advantages and drawbacks of each. (*10 marks*)

   (b) List the two forces that drive natural ventilation. Compare the benefits and disadvantages of each. (*10 marks*)

   (c) Shelter belts are often used to "protect" housing developments and are claimed to reduce heating costs. Explain how this could be true. (*5 marks*)

   (d) Define the term "wind speed ratio". Discuss how an urban planner may be able to influence the design of a large development so that the wind speed ratio is less than 1. What benefits will this bring to the people who use the site. (*10 marks*)

   (e) Briefly discuss how an architect might alleviate pedestrian discomfort around a tall building on a windy site. (*5 marks*)

   (f) A room (4 m deep, by 2 m wide, by 2.5 m high) is being ventilated with outside air at a rate of 6 air changes per hour. If the total heat gains (due to solar radiation, occupants, lights and machines) in the space is 30 W/m^2, estimate the internal temperature if the outdoor air temperature is 24°C. Assume the specific heat capacity and density of the air is 1.02 kJ/kgK and 1.12 kg/m^3 respectively. (*10 marks*)

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3. The architect of a small office building, of rectangular plan form (with dimensions of 30 by 15 metres and a floor to ceiling height of 3 metres), has decided that it will be mechanically ventilated. The system is to be used mainly for providing background ventilation and warm air heating in winter, but will also be used to assist night ventilation and daytime air movement during hot spells in summer.

   (a) Comment on the advantages and disadvantages of this arrangement in terms of its energy and thermal comfort performance, as compared to full natural ventilation and full air conditioning. (*20 marks*)

   (b) If the building has an occupancy density of 1 person per 10 m^2, calculate the air change rate that you would consider necessary to maintain adequate air quality in the building during the winter months. (*5 marks*)

   (c) During the winter the system will operate at the higher air change rate of 4 air changes per hour in order to provide sufficient heating. If the pressure loss in the ductwork system is 100 Pa, and the fan operates at 75% efficiency, calculate the air power, then the fan power, that will be necessary to provide the ventilation. (*5 marks*)

   (d) During hot spells, it is intended to run the ventilation system at 8 air changes per hour during the night to pre-cool the structure. The additional air changes are to be achieved by increasing the speed of rotation of the fan. By what factor would the fan speed need to increase to achieve this new ventilation rate? To what value would the total pressure losses rise at the increased ventilation rate? (*5 marks*)

   (e) Calculate the fan power, then the air power required to provide this new ventilation rate of 8 air changes per hour, if the fan efficiency degrades to 70% under these conditions. (*5 marks*)

   (f) If the ventilation and heating system runs at 4 air changes per hour from 8:00 am to 6:00 pm, five days a week, during the winter period from the beginning of October to the end of May (35 weeks) and then at 8 air changes per hour from midnight to 8:00am, seven days a week, during July and August (8 weeks), calculate the annual cost of running the fan, if electricity costs 7 p/kWh during the day and 4 p/kWh at night. (*10 marks*)

4. (a) Explain why the fresh air fed into mechanically ventilated and air conditioned buildings is always filtered. (*10 marks*)

   (b) Discuss briefly the mechanisms the human body uses to lessen the potentially ill affects of inhaled particles on the lungs. (*10 marks*)

   (c) Discuss the factors that affect the efficiency of filtration of particulate filters in mechanical ventilation and air conditioning systems. (*5 marks*)

   (d) Explain briefly how an electrostatic filter removes particulate matter from a supply of fresh air to a building. (*8 marks*)

   (e) Discuss the advantages and disadvantages of electrostatic filtration in air conditioning systems. (*7 marks*)

   (f) Discuss in detail the energy implications surrounding filtration and fresh air supply in mechanically ventilated and air conditioned buildings. (*10 marks*)

END OF PAPER