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   : **09-MAY-03**

TIME   : **14.30**

TIME ALLOWED   : **2 Hours**

TURN OVER

UNIVERSITY OF LONDON

MSc DEGREE in SCIENCE in BUILT ENVIRONMENT 2002

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. The organisation which owns one of the largest chains of department stores in the UK is considering building itself a new corporate headquarters, for its central administrative staff, in an office park just outside the M25 near London. The site is spacious and open and the ambient air quality is good. The organisation wishes to have a high profile, environment-friendly building, which it can promote as showing its concern for the environment. It also wants to ensure that the internal conditions of the new building will not hinder the work of its staff, who will mainly be involved with general office tasks.

You are the designer of the building and its environmental systems and have been called to a meeting with the client to discuss initial ideas.

(a) You have suggested a totally naturally ventilated solution, with winter time heating running off gas-fired condensing boilers.

    (i) What overall shape will you propose for the building and why? (*5 marks*)
    (ii) What type of materials will you suggest for the construction of the building? Explain your choice? (*5 marks*)
    (iii) What other features will you propose to limit energy consumption for the heating system? (*5 marks*)
    (iv) What other features will you propose to limit extreme conditions during the summer? (*5 marks*)
    (v) How will you ensure good air quality in winter, when the occupants will want to keep the windows shut? (*5 marks*)

(b) You have suggested a seasonal mixed-mode solution, again with winter heating running off gas-fired condensing boilers.

    (i) Explain to the client the seasonal mixed-mode concept. (*5 marks*)
    (ii) What are its advantages and disadvantages over a fully naturally ventilated approach? (*5 marks*)
    (iii) The actual solution you suggest involves hollow core slabs. Explain the concept and the advantages of this solution. (*10 marks*)
    (iv) Explain how it is possible that a seasonal mixed-mode building could use less energy per square metre per year than a fully naturally ventilated one. (*5 marks*)

2. (a) Explain the concept, "build tight, ventilate right", in terms of the environmental and energy performance of buildings. *(10 marks)*

(b) Explain why shelter belts can reduce the energy needed to heat buildings. *(5 marks)*

(c) What do you consider to be the most important attributes of a shelter belt? *(5 marks)*

(d) The *wind speed ratio* is used to characterise the effect of buildings on wind speed at pedestrian level. How is *wind speed ratio* formally defined? What urban form is likely to produce a wind speed ratio less than 1? What urban form is likely to produce a wind speed ratio greater than 1? *(5 marks)*

(e) Tall buildings can be particularly problematic in windy weather as regards pedestrian comfort. Discuss in what ways you might modify the design of an existing slab block to reduce wind speeds at street level? *(5 marks)*

(f) Explain the difference between wind-driven and stack-driven natural ventilation in buildings. Compare the benefits and drawbacks of each. *(10 marks)*

(g) In summer a room is ventilated naturally through the stack effect. Tests show that this provides 1 air change per hour. If the room has a floor area of 24 m^2, and is 2.8m high, how much fresh air (in m^3/s or litres/s) is being supplied. In order to maintain good air quality, what is your recommendation regarding the maximum number of people who should work in this room? Why? *(10 marks)*

3. It is recognised that the air quality within a large open plan area, 20 m long by 15 m wide by 3 m high, in a naturally ventilated office building is rather poor, and a mechanical ventilation system is proposed. The designers want it to provide a maximum of 10 air changes per hour at night for pre-cooling in summer with 6 air changes per hour during the day. The fan and ductwork supply system has been designed.

(a) The fan chosen by the designers has the following performance, when running at 17 revolutions per second, as tested in the factory.

Volumetric flow rate (m^3/s)	0.2	0.6	1.0	1.4	1.8	2.2	2.6	3.0
Fan total pressure (pa)	410	418	420	417	405	390	375	355

After the ductwork has been installed, a re-estimation of the pressure loss suggests a value of 170 Pa when the duct carries 1.9 m^3/s. *Using the graph paper provided,* estimate the number of air changes per hour that will actually be delivered by the fan, when connected to the installed ductwork system. *(25 marks)*

(b) Calculate the approximate fan speeds that will be required to achieve the design air change rate of 10 per hour and the day time air change rate of 6 per hour. *(5 marks)*

(c) From your graph, read off the fan total pressures that will be developed when the fan is delivering 10 AND 6 air changes per hour. Assuming the efficiency of the fan to be 75% across its performance range, estimate the fan power that will be required to deliver the 10 air changes per hour AND the 6 air changes per hour (ac/h). *(10 marks)*

(d) If the fan runs from 10:00 pm until 6:00 am at 10 ac/h at a cost of 3 p/kWh, and from 6:00 am until 10:00 pm at 6 ac/h at a cost of 7 p/kWh, what will be the daily running cost of the fan? *(10 marks)*

CONTINUED

4. (a) Explain how any **TWO** of the following mechanisms remove dust particles from the air in filters in mechanical ventilation systems: *straining, direct interception, inertial interception, diffusion.* (*6 marks*)

(b) Explain how electrostatic filters work in mechanical ventilation and air conditioning systems, and discuss their advantages and disadvantages. (*9 marks*)

(c) What is the purpose of pre-filters in an air handling unit? (*5 marks*)

(d) Explain why the fresh air supplied by a mechanical ventilation system is filtered? (*10 marks*)

(e) Discuss the energy implications of filtering air in mechanical ventilation and air conditioning systems? (*10 marks*)

(f) List the main sources of gaseous pollution within buildings, then give the reasons why this pollution needs to be controlled? What control mechanisms would normally be used in an office building to control gaseous pollution? (*10 marks*)

END OF PAPER