Cork Institute of Technology

Higher Certificate in Engineering in Electrical Engineering – Award

(NFQ Level 6)

Summer 2007

Industrial Services

(Time: 3 Hours)

Instructions
Attemp **Five** questions.

All questions carry equal marks.

Put your name on all handouts and return with your answer book

Examiners: Dr. E. M^{c}Quade
Mr. M. Hennessey
Mr. F. Delaney

Q1 (a) With respect to the Energy Performance of Buildings Directive state what is explicitly required under:

Article 3 (2 marks)

Article 4 (2 marks)

Article 5 (2 marks)

Article 6 (2 marks)

Article 7 (2 marks)

(b) Explain what provisions the Irish government has put in place to implement Articles 3,4 and 7.

(10 marks)

(c) Detail the timeframe for the implementation of Articles 5,6 and 7.

(5 marks)

Q2 (a) What are the relative percentages of heat loss by evaporation, convection and evaporation from the human body? (3 marks)

(b) Draw a simple sketch showing the heat transfer mechanisms that take place between the human body and the working environment. (4 marks)

(c) Briefly explain the classifications that are commonly applied to heating systems. (4 marks)

(d) Describe the main operating principles of radiant heating. (5 marks)

(e) Draw a neat labelled sketch of a gas fired radiant tube. (4 marks)

Q3 (a) Define ventilation. (2 marks)

(b) List 4 air contaminants that may be reduced by ventilation. (2 marks)

(c) What is the recommended ventilation rate for an office environment? (1 mark)

(d) Draw a block diagram showing the classification of ventilation and air conditioning systems. (5 marks)

(e) Explain the term natural ventilation. (2 marks)

(f) List 4 examples of natural ventilation systems. (2 marks)

(g) Describe using a neat sketch the process of single-sided ventilation as a form of natural ventilation. (3 marks)

(h) Describe using a neat sketch the process of cross ventilation as a form of natural ventilation. (3 marks)

Q4 Write concise note on the following combined heat and power (CHP) topics:

(a) Efficiency of CHP systems compared to the efficiency of boiler systems for heat and the national grid for power. (5 marks)

(b) Heat to power ratios and prime movers. (5 marks)

(c) Matching heat to power ratios to the heat and power profile of a building. (5 marks)

(d) Suitable applications for CHP units. (5 marks)

Q5 (a) Explain the following pump terms:

Pump curve (2 marks)

System Curve (2 marks)

Operating point (2 marks)

(b) The design flow rate for a pumped system is 75 m^3/hr. At design stage the pump head was estimated as 13 m water. Based on these figures a HTF4 80-200/40 pump with a 220mm diameter impeller was purchased and installed (see attached pump curves Figure Q5.1). When the pump was first run at commissioning stage the volumetric flow rate was found to be 90m^3/hr.

i. If the design volumetric flow is achieved by throttling the flow using commissioning valves calculate the pump power. Check your answer by comparing it to the pump power read directly from the power curves.

(4 marks)

ii. If the design volumetric flow is achieved by reducing the pump speed calculate the pump power. (8 marks)

iii. Which of the two flow correction methods is the most economical? Explain your answer. (2 marks)

Note: take the density of water to be 1000 kgm^{-3}

Q6 (a) What is the difference between a forward curved and a backward curved centrifugal fan?

(2 marks)

(b) What is meant by the term bifurcated when applied to axial fans?

(2 marks)

(c) Give one example of a typical application for a forward curved centrifugal fan and a bifurcated axial fan. (2 marks)

(d) A fan delivers 4.5 m^3s^{-1} of air with a total pressure of 250 Pa.

i. If the fan efficiency is 70%, calculate the total fan power. (4 marks)

ii. If the fan speed is reduced to give a volumetric flow rate of 4.0 m^3s^{-1}, calculate the new fan total pressure and the new fan power. (4 marks)

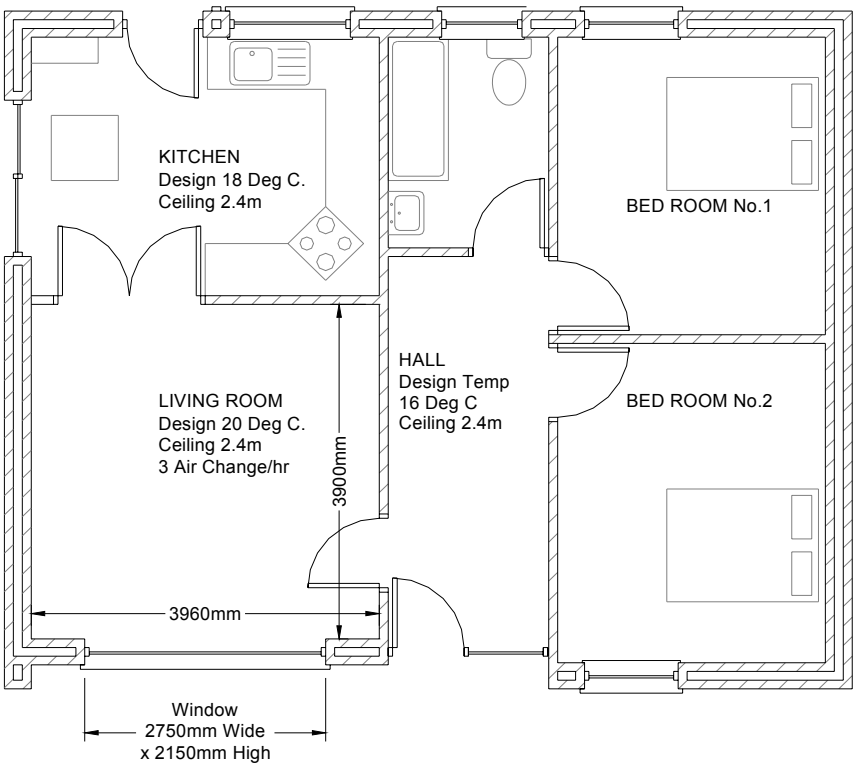
(e) State 3 reasons why it is necessary to be able to vary/control volumetric flow rates through fans and list 3 methods of achieving this. (6 Marks)

Q7 (a) Explain the terms convection and conduction with respect to heat transfer. (2 marks)

(b) With respect to heat loss from a building explain what is meant by infiltration. (2 marks)

(c) Explain what is meant by the term "U value". (2 marks)

(d) Fig 2.1 shows the plan of a single storey dwelling. From the data given and using convection heating, calculate the total rate of heat loss for the living room area. (14 marks)



U-Values	W/m^{2}K
Floor	0.3
External Wall	0.4
Internal Wall	2.2
Windows	2.8
Doors	2.4
Ceiling/Roof	0.2

All internal doors
1m wide x 2m high

Outside air design
Temp minus 1 Deg C

Formulae

$$Q_{WP} = \frac{FAD}{R} \qquad R = \frac{1.013 + P}{1.013} \qquad Q_{WP} = vA$$

$$\frac{h_A}{h_W} = \frac{\rho_W}{\rho_A} \qquad \frac{P}{\rho g} + \frac{v^2}{2g} = H$$

$$\frac{N_2}{N_1} = \frac{Q_2}{Q_1} \qquad \left(\frac{N_2}{N_1}\right)^2 = \left(\frac{P_{R2}}{P_{R1}}\right) \qquad \left(\frac{N_2}{N_1}\right)^3 = \left(\frac{P_{W2}}{P_{W1}}\right) \qquad \eta = \frac{P_R Q}{P_w}$$

$$Q = \frac{KA\Delta t}{L} \qquad Q = h_c A\Delta t \qquad Q = UA\Delta t \qquad U = \frac{1}{\sum\left(\frac{1}{h_c}, \frac{L}{K}\right)} \qquad U = \frac{1}{\sum\left(r, \frac{L}{K}\right)}$$

$$Q = \rho v C\Delta t \qquad Q = \frac{\rho VNC\Delta t}{3600} \qquad Q = \frac{1}{3} NV\Delta t$$

$$Q = \dot{m} C\Delta t$$

Density of Water, $\rho_{Water} = 1000$ kg/m^3

Density of Air, $\rho_{Air} = 1.2$ kg/m^3

Specific Heat capacity of Water, $C_{Water} = 4200$ J/kg^{o}C

Specific Heat Capacity of Air, $C_{Air} = 1000$ J/kg^{o}C

Gravitational Constant, g = 9.81 m/s^2

LOWARA

QS.1

HYDRAULIC PERFORMANCE CURVES, HTF4 SERIES, 50 Hz, 4 POLE

HTF4 80-200	1450 rpm	04