Cork Institute of Technology

Higher Certificate in Engineering in Electrical Engineering - Award

(NFQ – Level 6)

Autumn 2006

Industrial Services

(Time: 3 Hours)

Instructions
Attempt **Five** questions.

All questions carry equal marks.

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

Examiners: Dr. E. McQuade
Mr. M. Hennessey
Mr. F. Delaney

Q1. (a) Using a neat, labelled sketch, describe the operation of a vapour compression refrigeration system. (10 marks)

(b) State 4 properties of a refrigerant. (4 marks)

(c) Sketch a schematic for a split D-X system with a ceiling mounted cassette unit suitable for cooling a small office room. Clearly show which pieces of equipment are internally and externally mounted. (6 marks)

Q2. 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.

b) Heat to power ratios and prime movers.

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

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

Q3. (a) Explain the terms convection and conduction with respect to heat transfer. (2 marks)

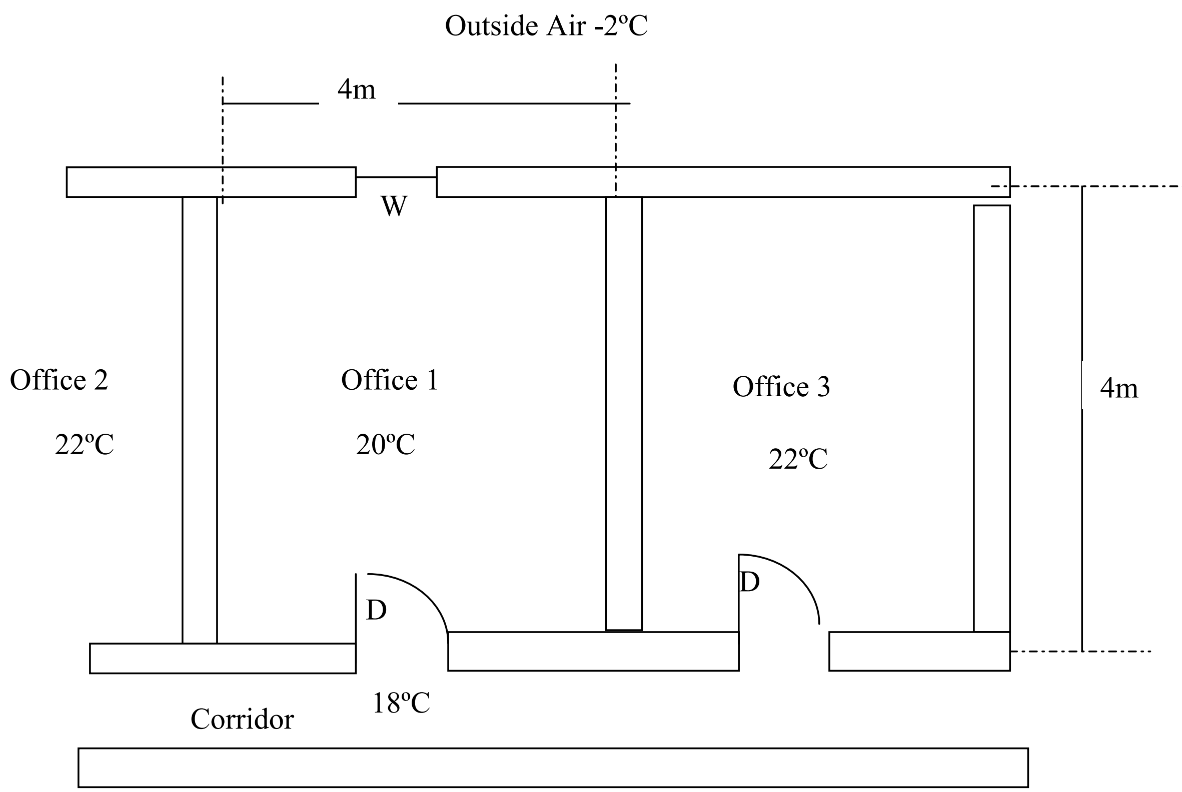
(b) Explain the term Overall Heat Transfer Coefficient (U-value) and state the SI unit for Overall Heat Transfer Coefficient (U-value). (2 marks)

(c) Calculate the total heat transfer rate in kilowatts (heat loss) for Office1 shown below. Ignore heat loss through the ceiling and floor. The outside air temperature is –2 °C. Use 1 air change per hour for infiltration (N=1). (Note: there are heat losses from Office 1 to the outside and to the corridor but heat gains from Office 2 and Office 3). (16 marks)

Air Changes Per Hour = 1

Structure	**U value ($W/m^{2}{}^{o}C$)**
Window	2.2
Door	2.3
Internal Wall	1.6
External Wall	1.5

Office1 Height 2.4m W-Window 1.5m x 1m D- Door 1m x 2m



Q4. The design flow rate for a piping system is 90 m^3/hr. At design stage the pump head was estimated as 22m water. Based on these figures an 80-250/92 pump with a 270mm diameter impeller was purchased and installed (see attached pump curves). When the pump was first run at commissioning stage the volumetric flow rate was found to be 115 m^3/hr.

(a) Estimate the pump power at 115 m^3/hr from the pump curves. (3 marks)

(b) Assuming the design flow rate of 90 m^3/hr is achieved by throttling the flow using commissioning valves, determine the new pump power both by calculation and by using the pump curves. (7 marks)

(c) If a variable speed drive is used to achieve the correct flow rate of 90 m^3/hr, calculate the pump power. (10 marks)

Q5. (a) Write concise note on the following topics with regards to Building Energy Management System (BEMS):

Optimum Start/Stop

Temperature Reset

Sequencing Control

Free Cooling Cycle (12 marks)

(b) Give one example of a digital input, an analogue input, a digital output and an analogue output for a BEMS system. (4 marks)

(c) Radiator systems use a form of control known as compensated heating. Describe this form of control. (4 marks)

Q6. Discuss the main provisions of the Energy Performance of Buildings Directive 2002/91/EC. (20 marks)

Q7. (a) Distinguish clearly between the terms ventilation, comfort cooling and air conditioning. (3 marks)

(b) Sketch a central air handling unit clearly identifying the following components: intake motorised damper, frost coil, pre-filter, recirculation damper, main filters, heating coil and supply fan. (7 marks)

(c) Describe, using a neat sketch, the operation of a fan coil unit (FCU) air conditioning system suitable for a modern office block. (10 marks)

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

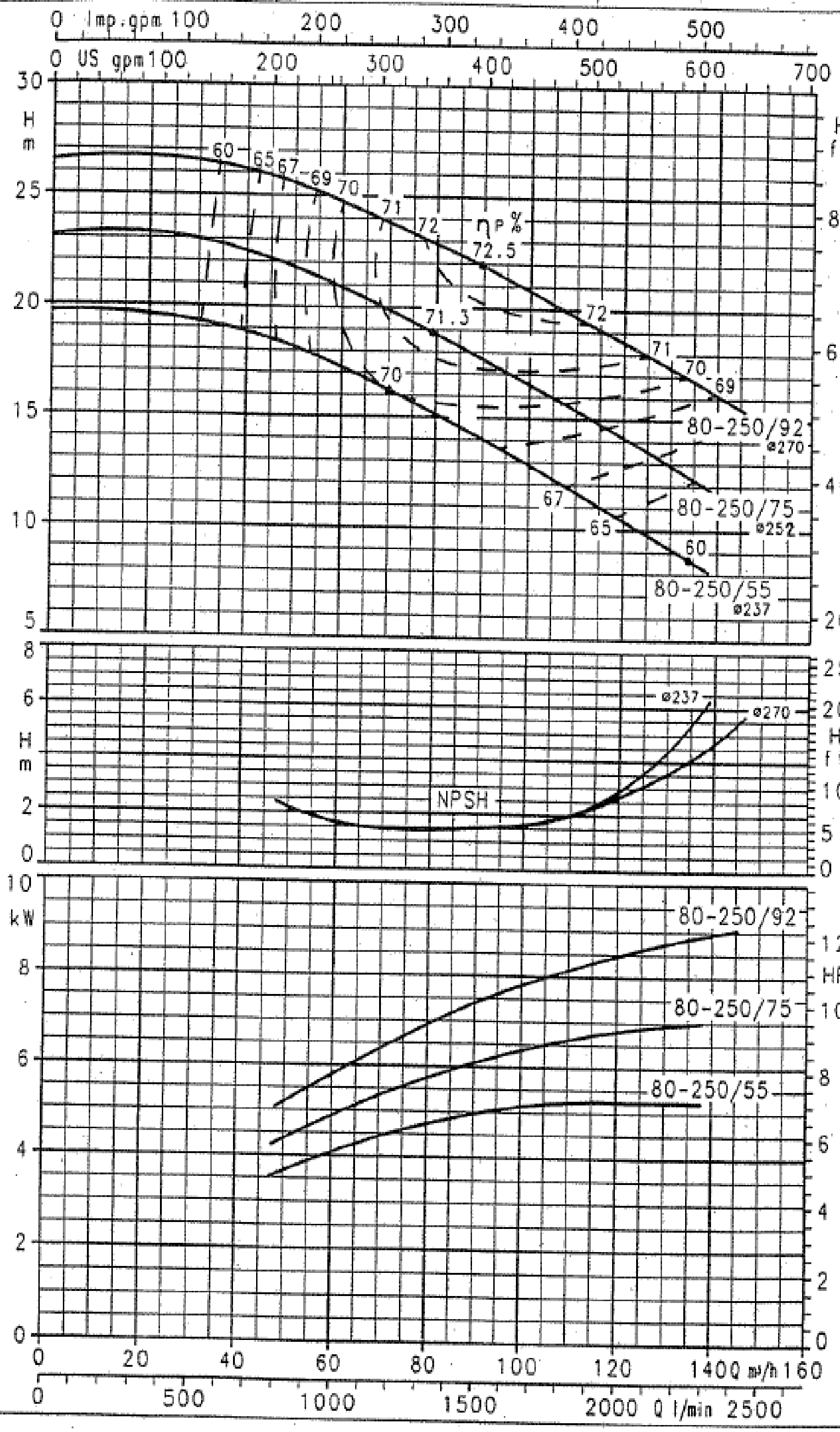
Specific Heat Capacity of Air, $C_{Air} = 1000$ J/kg^{o}C

Gravitational Constant, g = 9.81 m/s^2

LOWARA Q6

HYDRAULIC PERFORMANCE CURVES, HTF4 SERIES, 50 Hz, 4 POLES (1450 rpm)

HTF4 80-250	1450 rpm	04248D



The declared NPSH values are laboratory values: for practical use we suggest increasing these values by 0,5 m.
The declared performances and power are valid for liquids with density ρ = 1.0 Kg/dm³ and kinematic viscosity γ = 1 mm²/sec.