



# **EXAMINATIONS 2012 / 2013** **ARHOLIADAU 2012 / 2013**

**Semester 1**

**FACULTY OF: Applied Design & Engineering**

**NAME OF COURSE/PROGRAMME:**

**BEng Mechanical & Manufacturing Engineering**

**YEAR OR LEVEL:**

**Level 6**

**NAME OF MODULE/UNIT/EXAM PAPER:**

**Energy and Environmental Technology**

**MODULE NO:**

**M3X8858**

**DATE OF EXAMINATION:**

**19<sup>th</sup> February 2013**

**EXAMINATION TIMES:**

**START TIME:**

**2.00 pm**

**FINISH TIME:**

**4.00 pm**

**TIME ALLOWED:**

**2 hours**

## **INSTRUCTIONS TO CANDIDATES:**

Students should attempt 3 out of 4 questions.

Calculators may be used but all working out must be shown.

### **Question 1**

Lighting is vital for most organisations, but equipment, fittings and controls often receive very little maintenance.

- a) A large welding bay 18m x 12m and 5m high has a grey ceiling and light stone coloured walls. The working plane is 1.25m above the floor and the luminance factors are 50 for the ceiling and 50 for the walls. The maintenance factor is assumed to be 0.85. The illuminance required for task is 550 lumens/m and the lighting design lumens are taken as 4000 lumens.

- (i) Calculate the number of luminaires required.

**(6 marks)**

- (ii) New mirror luminaires are too used and their spacing-to-height ratio (SHR) is 2.15. Calculate the ratio of spacing to height above the working plane.

**(3 marks)**

- (iii) If each luminaire uses 220w calculate the annual energy consumption for the welding bay assuming that it is in use for 12 hours a day, 5 days a week, for 48 weeks.

**(4 marks)**

- (iv) Calculate the annual energy costs of lighting the welding bay if electricity costs 14p/kWh.

**(2 marks)**

- b) An external report has found that the welding bay is often not occupied and on average the lights are left on unnecessarily for over 3 hours a day.

Discuss what measures the company could implement to reduce its energy consumption from lighting in the welding bay.

**(10 marks)**

### **Question 2**

Many industrial processes create unwanted emissions in the form of particulate matter. Not only can these particulates be extremely harmful to the environment they can also affect the health of employees.

As the environmental manager for a large chemical plant you have been charged with evaluating a range of technology for cleaning up particulate emissions that are flammable with particles ranging in size from 50µm to 0.5µm.

Prepare a report that clearly evaluates the range of technology available for dealing with these particulate emissions and make suggestions as to which type of technology would be most appropriate.

**(25 marks)**

### **Question 3**

Reducing environmental impact is a major concern for most manufacturing companies.

a) Comprehensively explain what is meant by the term pollution.

**(6 marks)**

b) Discuss the principal mechanisms that are used to control environmental pollution, using examples to support your answer.

**(8 marks)**

c) Environmental impact assessment for a product adopts the cradle to grave approach using life cycle analysis. Demonstrate how life cycle analysis can be used to assess the environmental impact of a product of your choice throughout its life cycle.

**(11 marks)**

#### Question 4

With rising energy costs it is important that buildings are well insulated and thermally efficient.

- a) A room has an external wall with a U-value of 1.75 w/mk and contains air at 22°C when the outside temperature is -1°C. The internal surface resistance is 0.15m k/w.

Calculate the temperature on the internal surface of the wall using the following formula.

$$\frac{\Delta\theta}{\theta T} = \frac{R}{RT}$$

(6 marks)

- b) Distinguish between the terms fabric heat loss and ventilation heat loss.

(4 marks)

- c) A structural engineer has calculated that fabric heat loss from a building is 125KW when the outside temperature is 2°C and the inside temperature is 18°C. The volume of the building is 80m<sup>3</sup> and there are 2 air changes per hour. The constant is equivalent to 1300J/mk.

- (i) Calculate the ventilation heat loss using the formula below.

$$Q_v = \text{Constant} \times n \times V \times (t_{ai} - t_{ao}) / 3600$$

(5 marks)

- (ii) Calculate the total heat loss.

(1 mark)

- d) A building is occupied 5 days per week for 12 hours per day. It is of a lightweight construction and heated by a modern highly responsive gas warm heating system with a seasonal efficiency of 90%. Natural gas costs 12.5p/kWh and the building is located in a region which experiences 2625 degree days per year. Using the heat loss value calculated part (c) and the attached values in Tables 2, 3 and 4 calculate the annual energy demand and the annual fuel costs using the equation below.

$$E = \frac{Q_T}{t_{ai} - t_{ao}} \times \text{SDD} \times 24 \times \frac{1}{\eta}$$

(9 marks)

Table 1: Utilisation factors

**Luminance factors Room Index**

| Ceiling | Walls | 0.75 | 1  | 1.25 | 1.5 | 2  | 2.5 | 3  | 4  | 5  |
|---------|-------|------|----|------|-----|----|-----|----|----|----|
| 70      | 50    | 48   | 53 | 59   | 64  | 71 | 75  | 79 | 83 | 86 |
| 70      | 30    | 40   | 46 | 51   | 57  | 64 | 69  | 73 | 78 | 82 |
| 70      | 10    | 35   | 40 | 46   | 51  | 59 | 64  | 68 | 74 | 78 |
| 50      | 50    | 43   | 48 | 52   | 57  | 63 | 67  | 70 | 74 | 76 |
| 50      | 30    | 37   | 41 | 46   | 51  | 57 | 62  | 65 | 70 | 73 |
| 50      | 10    | 33   | 37 | 42   | 46  | 53 | 58  | 61 | 67 | 70 |
| 30      | 50    | 39   | 42 | 46   | 50  | 55 | 59  | 61 | 65 | 67 |
| 30      | 30    | 34   | 37 | 42   | 46  | 51 | 55  | 58 | 62 | 65 |
| 30      | 10    | 30   | 33 | 38   | 42  | 48 | 52  | 55 | 59 | 62 |

Table 2: Correction Factor for Length of Working Week

| Occupied Days per Week | Lightweight building | Heavyweight building |
|------------------------|----------------------|----------------------|
| 7 days                 | 1.0                  | 1.0                  |
| 5 days                 | 0.75                 | 0.85                 |

Table 3: Correction Factor Length of Working Day

| Occupied Period | Lightweight building | Heavyweight building |
|-----------------|----------------------|----------------------|
| 4 hours         | 0.68                 | 0.96                 |
| 8 hours         | 1.00                 | 1.00                 |
| 12 hours        | 1.25                 | 1.02                 |
| 16 hours        | 1.40                 | 1.03                 |

Table 4: Correction Factor for the Response of Building and Plant

| Type of heating                   | Lightweight building | Medium weight building | Heavyweight building |
|-----------------------------------|----------------------|------------------------|----------------------|
| Continuous                        | 1.00                 | 1.00                   | 1.00                 |
| Intermittent (responsive plant)   | 0.55                 | 0.70                   | 0.85                 |
| Intermittent (with long time lag) | 0.70                 | 0.85                   | 0.95                 |