

**THE UNIVERSITY OF ADELAIDE**  
**DEPARTMENT OF MECHANICAL ENGINEERING**

**EXAMINATION FOR THE DEGREE OF B.E.**

**8682: ENGINEERING AND THE ENVIRONMENT**

**JUNE, 2001**

**TIME: 3 HOURS and 10 MINUTES**

[It is recommended that you spend ten minutes reading the paper and planning your approach before the exam begins.]

[The use of notes, textbooks and calculating devices is permitted in the examination room.]

Attempt **ALL FIVE** questions

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1. A foreman in an Australian factory operates for 2 hours each day a machine that produces 95dB(A) sound pressure level at the operator position. For the rest of the 8-hour day the foreman is in an office where the sound pressure level is 70dB(A).
- (a) Calculate the foreman's equivalent continuous sound level averaged over 8 hours. [5 marks]
- (b) Calculate the foreman's A-weighted sound exposure level (8-hour). [5 marks]
- (c) What is the maximum number of hours per day that the foreman could use the machine and still maintain a noise dose of 1.0 or less. [5 marks]
- (d) If the level at the operator location of the machine is 91dB(A) with the machine switched off, what is the sound pressure level due to the machine only. [5 marks]

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2. The sound power level of a machine that radiates sound equally in all directions in a factory of dimensions 20m × 25m × 5m is 113 dB in the 500Hz octave band. The space average Sabine absorption coefficient for the 500Hz octave band is 0.1.
- (a) Calculate the distance from the machine (located in the middle of a hard floor and away from any other reflecting surfaces) that the reverberant sound pressure level will equal the direct sound pressure level at 500Hz. [5 marks]
- (b) What would this distance be if the machine were located at the junction of the floor and one wall? [5 marks]
- (c) What would be the result in part (a) if the ceiling were covered with ceiling tiles having a Sabine absorption coefficient of 0.5? [5 marks]
- (d) Comment on the effectiveness of the ceiling tiles on the noise exposure of the machine operator if the distance of the operator from the machine is 0.5m [5 marks]
3. The rms acceleration levels measured on the floor of an office occur continuously and are listed in the table below. Would you expect any adverse comment? You can assume that the levels in frequency bands not shown in the table are negligible. Explain how you arrived at your answer.

[10 marks]

1/3 octave band centre frequency (Hz)	1.0	2.0	4
$a(m/s^2)$ z-direction (vertical), rms	0.03	0.025	0.015
$a(m/s^2)$ x-direction, rms	0.01	0.01	0.025

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4. A fruit and vegetable canning company proposes to establish a new factory on a large and spacious site in the country. It will operate on a continuous basis. The factory has already been designed to include all viable water reuse options and has ensured suitable separation of contaminated and clean flows, but it must discharge wastewater into a nearby river. The flow rate and the quality of the wastewater are both variable, and depend on the various stages in the production cycle. The conditions for development include a requirement that the wastewater discharge is treated on site before it is discharged, so that the wastewater meets certain water quality standards.
- (a) What issues and water quality contaminants should be considered in the development of a suitable wastewater treatment process for the wastewater from the factory?  
[5 marks]
- (b) What are the potential impacts of each of the water contaminants on the river if they are left untreated?  
[7 marks]
- (c) Select and briefly give reasons for an appropriate treatment method for each of the contaminants. Bear in mind that some treatments methods may be used to address more than one contaminant, and that some are likely to be cheaper to install and operate than others.  
[8 marks]
- (d) Suggest a suitable sequence for the various treatment methods and give an explanation for your plan.  
[5 marks]
5. Alumina is the intermediate product between bauxite and aluminium. It emerges from the process with a density of  $1,800 \text{ kg/m}^3$  and a temperature of  $365^\circ\text{C}$ , with a size distribution as shown below. The actual volumetric flow rate, at the above temperature, is  $2750 \text{ m}^3/\text{hr}$ .

Particle Size ( $\mu\text{m}$ )	1	5	20	60	160
Weight percentage less than	15	28	41	73	94

A two-stage collection system is required, both to capture the alumina, which is of high value, and to ensure that emission standards are met. The first stage will use a cyclone system, and is required to collect at least 95% of the total alumina. The type of system to be used for the second stage is yet to be decided and is to remove as much as possible of the residual 5%.

- (a) Assume that it has already been decided that the cyclones will comprise one or more banks (i.e. stages) of 4 parallel cyclones of the standard high efficiency design. Each cyclone is to be identical. What is the diameter of the cyclones?

[3 marks]

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- (b) Discuss briefly the issues associated with predicting performance using the Stairmand design when using a cyclone of the above cyclone diameter. [3 marks]
- (c) What is the efficiency of each set of 4 parallel cyclones? [9marks]
- (d) How many banks of cyclones are required in series to achieve the desired specification. [2 marks]
- (e) Consider next the second stage of the collection system. Discuss the advantages and disadvantages of a bag filter system, an electrostatic precipitator system, and a wet scrubber system. (No calculations are needed.) [8 marks]