THE UNIVERSITY OF ADELAIDE
DEPARTMENT OF MECHANICAL ENGINEERING

EXAMINATION FOR THE DEGREE OF B.E.

8682: ENGINEERING AND THE ENVIRONMENT

NOVEMBER, 2000

TIME: 3 HOURS

[In addition, candidates are allowed ten minutes before the exam begins, to read the paper.]

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

Attempt **ALL EIGHT** questions

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1. You are working for a process industry in a small country town. You notice that untreated effluent is being discharged into a nearby river. You are not sure of the nature of the effluent but you suspect that it is harmful to the river ecosystem and may also be harmful to downstream users who use the water for irrigation and washing. You also know that if your industry ceases to operate the town will die as there are no other employment opportunities nearby. Refer to the tenets of the IEAust Code of Ethics in your answer and restrict your answer to between ½ and ¾ of a page.

[10 marks]

2. (a) Using the equation for the speed of sound as a function of gas properties find the ratio of the speed of sound in Helium to that in air. Helium has a molecular weight of 4g/mole and it is a monatomic gas for which the average number of excited degrees of freedom is 3. Thus the ratio of specific heats $\gamma = (3+2)/3$. Air has a molecular weight of 29 g/mole.

[10 marks]

(b) Explain why taking a mouthful of helium from a balloon makes you speak with a high pitched voice.

[5 marks]

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3. The sound power radiated by a small source in free space is 120dB. When the source is placed on a concrete floor, the sound pressure level at a particular location 10 metres away is measured as 110dB. What is the directivity index (dB) of the source in the direction of the measurement point due to:

   (a) the location of the source on the floor.

   [3 marks]

   (b) the non uniform radiation characteristics of the source.

   [7 marks]

4. The sound pressure level measured at three locations around a machine is used to estimate the sound power level of a particular machine. The sound pressure levels measured at the three locations in the factory with the machine running in the **1/3 OCTAVE** bands 400Hz, 500Hz and 630Hz are 98, 102, and 96 dB respectively and with the machine turned off the levels are 95, 98 and 94 respectively.

   (a) Calculate the L_{eq} for the 500Hz **OCTAVE BAND** for the machine only with no background noise influence.

   [5 marks]

   (b) If an enclosure were placed around the machine that resulted in noise reductions of 15dB, 20 dB, and 23dB in the three 1/3 octave bands respectively, what would be the expected noise reduction for a uniform noise spectrum in the 500 octave band?

   [5marks]

5. A reference sound source having a sound power level of 95.5dB(A) produces a reverberant field of 88dB(A) in an equipment room. Existing equipment in the room produces a reverberant field level of 85dB(A).

   If 5 new machines, all producing the same sound power level, are to be introduced, what is the allowable maximum sound power level of each machine so that the noise level in the room does not exceed 90dB(A)? State any assumptions that have to be made to answer this question.

   [15 marks]

6. Given the rms vibration levels measured on a mining truck in the table on the next page, calculate (for an exposure time of 8 hours):

   (a) the estimated vibration dose value for each axis

   [5 marks]

   (b) the combined vibration dose value for all three axes

   [5 marks]

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6. (Cont.)(c) What is the allowable exposure time to prevent exceedance of the allowable exposure limit

[5 marks]

1/3 octave band centre frequency (Hz)	1.0	2.0	4
a(m/s^2) z-direction, rms	3.15	0.63	0.63
a(m/s^2) y-direction, rms	0.63	3.15	3.15

Assume that acceleration values for frequencies or axes not listed in the table are zero.

7. A wooden furniture factory produces a lot of saw dust, both from sawing and sanding. Although the saw dust comprises a wide range of sizes, the most irritating is that part consisting of particles with a mean diameter of less than 10μm. Consequently you are required to produce a cyclone design that achieves a 95% capture rate of 5μm particles.

The sawdust has a density of 640 kg/m^3 and emerges at a temperature of 55 ^{0}C. The volumetric flow rate of the system is 960 m^3/hr.

(a) To keep costs down you are required to use a system with no more than two parallel streams. What diameter will your standard cyclones be.

[3 marks]

(b) Choose an appropriate number of cyclones in series to achieve the desired specification. What is the efficiency of your system?

[7 marks]

(c) Estimate the pressure drop through the system. Base your estimate solely on the dynamic head method.

[5 marks]

8. Discuss some of the options for dust collection other than cyclones which you may wish to consider. (No calculations are needed). What may be some of the health issues associated with the dust if the wood is treated with cyanide to prevent insects from damaging the timber?

[10 marks]