UNIVERSITY OF SWAZILAND
Faculty of Health Sciences

DEGREE IN ENVIRONMENTAL HEALTH SCIENCES
FINAL EXAMINATION PAPER 2005

TITLE OF PAPER	:	ACOUSTICS
COURSE CODE	:	EHS 535
DURATION	:	3 HOURS
MARKS	:	100
INSTRUCTIONS	:	READ THE QUESTIONS & INSTRUCTIONS CAREFULLY
	:	ANSWER ONLY **FIVE** QUESTIONS
	:	EACH QUESTION CARRIES 20 MARKS.
	:	WRITE NEATLY & CLEARLY
	:	NO PAPER SHOULD BE BROUGHT INTO OR OUT OF THE EXAMINATION ROOM.
	:	BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTE BY THE INVIGILATOR.

BACHELOR OF ENVIRONMENTAL HEALTH SCIENCE FINAL EXAMINATION

SUBJECT: ACOUSTICS – EHS 535

TOTAL MARKS: 100

ANSWER FIVE QUESTIONS. QUESTIONS 1 AND 2 ARE MULTIPLE CHOICE

QUESTION 1

Multiple choice: Write True or False against each letter corresponding to the following statements as they apply to acoustics.

a) The main hazards of noise are hearing loss and lack of communication.

b) The critical factors in noise exposure analysis are the A-weighted sound level; the frequency composition or spectrum of the noise; and the duration of the distribution of the noise during a typical working day.

c) Noise energy with predominant frequencies below 500 Hz has a greater potential for causing hearing loss than noise energy concentrated in the high frequency region.

d) The incidence of noise-induced hearing loss is indirectly related to total exposure time.

e) The audible range of frequencies for humans with good hearing is between 20 Hertz and 20 000 Hertz .

f) For most noise problems encountered in industry, the sound level meter and octave-band analyzers do not provide ample information.

g) If the wavelength of the sound is small in comparison with the size of an obstacle, the sound is reflected or scattered in many directions.

h) The Occupational Safety and Health Administration regulations neither require the control of noise exposures, nor employee protection against the effects of noise exposures, and the initiation of comprehensive and effective hearing conservation programs.

i) The effectiveness of a hearing conservation program depends only on the cooperation of employees.

j) The audiometric testing program should indicate whether hearing loss is being prevented by the employer's hearing conservation program.

[20 Marks]

QUESTION 2

Multiple choice: Write True or False against each letter corresponding to the following statements as they apply to acoustics.

a) An audiometer is used to test hearing by finding, the minimum intensity levels at which a person is able to distinguish various sounds.

b) People who work in noisy environments should have their hearing checked periodically to determine whether the noise exposure is producing a detrimental effect on hearing.

c) The further a person's threshold below the zero line of the audiogram, the smaller the hearing loss.

d) As a consequence of diffraction, a wall is of little use as a shield against low frequency sound, but it can be an effective barrier against high frequency sound.

e) The speed of sound does not vary with the density and compressibility of the medium through which it is traveling.

f) The more intense the sound from the audiometer must be for a person to hear it, the lesser is that individual's hearing loss.

g) Disease can impair hearing through fixation and interruption of the ossicles.

h) The A, B and C weighting curves were originally intended to approximate human ear responses at low, medium and high sound levels respectively.

i) Measurements of noise may be made to determine areas where a hearing risk may occur.

j) Noise control investigations to determine the characteristics of noise sources so that control measures may be taken do not require more accurate and sophisticated instruments capable of octave band frequency analysis and continuous recording.

[20 Marks]

QUESTION 3

a) Two sources of different frequency have sound pressure levels of 88dB and 85dB. What is the total sound pressure level?

[5 marks]

b) If an axial flow fan emits 1 watt of acoustic noise, what is its sound power level? **[3 marks]**

c) A worker in an engineering workshop is exposed to the following noise levels:

88 dB (A) for 4 hours
93 dB (A) for 1 hour
86 dB (A) for 3 hours

Determine the $L_{EP,d}$ for this individual.

[6 marks]

d) Four sources are radiating noise in a free field. The sources have the following sound power levels; 120 dB, 123 dB, 90 dB and 92 dB. What is the combined sound power level of these four sources?

[3 marks]

e) What are the purposes of a detailed noise survey?.

[3 marks]

QUESTION 4

A 5 m x 10 m x 3.5 m room has a 10 microwatt (1 $\mu W = 10^{-6}$ watts) sound source located in the centre of the 5 m wall where the floor and the wall meet. The absorption coefficients associated with the room are: walls $\alpha = 0.02$, floor $\alpha = 0.1$ and ceiling $\alpha = 0.26$. The sound pressure level is 62.8 dB.

a) Determine the sound pressure level in the room if absorption material of $\alpha = 0.9$ is added to the ceiling.

b) Determine the reverberation times for the room.

c) An employee is exposed to the following noise levels during the workday:

85 dBA for 3.75 hours
90 dBA for 2 hours
94 dBA for 2 hoours
95 dBA for 0.25 hours

Calculate the daily dose and give your conclusion about the exposure.

[4 marks]

N.B The permissible noise exposures are as follows:

Duration per day	**Sound level (dBA)**
8	90
6	92
4	95
1½	102
1	105
½	110
¼	115

QUESTION 5

a) Describe how noise is measured.

[16 marks]

b) What is the frequency of the predominant tone that would be emitted from an axial fan with four blades rotating at 6000 rpm? What are the frequencies of the expected additional tones?

[4 marks]

QUESTION 6.

a) A 5 m x 10 m x 3.4 m room has a 10 microwatt (1 $\mu W = 10^{-6}$ watts) sound source located in the centre of the 5 m wall where the floor and the wall meet. (See figure 1). The absorption coefficients associated with the room are: walls $\alpha = 0.02$, floor $\alpha = 0.1$ and ceiling $\alpha = 0.26$.

i) Find the sound pressure level at the centre of the room first taking into account the presence of the reverberant field and then assuming only direct sound radiation from the sound source.

[10 marks]

b) A 2.4m x 6m, 10.2cm thick brick wall has 0.3175cm thick 0.9m x 1.5m windows in it.

N.B The specific surface density for brick is 21 $kg/m^2/cm$ and for glass is 24.7 $kg/m^2/cm$.

ii) Compute the normal incidence transmission loss for the brick wall and windows individually and at a frequency of 500 Hz.

[6 marks]

iii) Compute the normal incidence transmission loss of the composite barrier composed of the brick wall and two windows.

[5 marks]