

UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
(BSC) IN ENVIRONMENTAL HEALTH
FINAL EXAMINATION PAPER 2005/6

TITLE OF PAPER : ACOUSTICS

COURSE CODE : EHS 535

DURATION : THREE HOURS

MARKS : 100

INSTRUCTIONS : ANSWER ONLY FIVE QUESTIONS.

: EACH QUESTION CARRIES 20 MARKS

: NO QUESTION PAPER SHOULD BE BROUGHT INTO NOT
OUT OF THE EXAMINATION ROOM

: BEGIN EACH QUESTION ON A SEPARATE SHEET OF
PAPER

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

QUESTION 1

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

- a) The product $p \times u$ is defined as the sound pressure per unit area.
- b) $\frac{dy}{dt} = w Y_{\max} \cos (wt-kx)$ is known as the particle velocity, u .
- c) $\frac{d^2Y}{dx^2} = \frac{1}{C^2} \frac{d^2Y}{dt^2}$ is the one dimensional wave equation governing the passage of a plane sound wave.
- d) In a forward-traveling wave there is reflection, 'free field' conditions.
- e) At any instant the distance of a particle from its mean position is known as the particle displacement.
- f) The bony labyrinth consists of the cochlea, the vestibule and the ossicles.
- g) Conductive hearing losses are losses of loudness.
- h) The further a person's threshold below the zero line of the audiogram, the smaller the hearing loss.
- i) Presbycusis is the natural reduced hearing sensitivity due to aging.
- j) 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.

[20 marks]

QUESTION 2

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

- a) Sound power is the total power coming from a source or the rate at which energy in the form of sound leaves the source.
- b) $C = \sqrt{\gamma RT}$, if $\gamma = 1.4$; $R = 0.287$ kJ/kg K; $T = 293$ K; therefore $C = 1480$ m/s
- c) Sound travels much more quickly in air than in water.
- d) The bulk modulus of elasticity, K , for a fluid can be written as: $K = - \frac{dp}{dV/V}$
- e) In the above equation (in d) above) a pressure rise, dp , acting on an element of volume, V , produces a Dilation or increase in volume, dV ; conversely a pressure drop, dp acting on the same element produces Condensation or reduction in volume dV .
- f) The noise-induced hearing losses that can be measured by pure tone audiometry are the threshold shifts that constitute a departure from a specified baseline or normal hearing level.
- g) Loudness depends primarily on sound pressure and is also affected by frequency.
- h) The noise exposure factors, namely; sound pressure level, frequency spectrum, period of exposure each day, and years of employment are the most important.
- i) The purposes of a detailed noise survey are to obtain specific information on noise levels, develop guidelines for establishing engineering and or administrative controls, define areas where hearing protection will required, and identify those areas where audiometric testing of employees is undesirable.
- j) The attenuation characteristics of a particular hearing protector must be considered before it is used for a specific application.

[20 Marks]

QUESTION 3.

- a) Ten sources, each producing on their own, 95dB. What is the combined sound power level of these sources?
[6 marks]
- b) A sound has a sound power of 1 Watt. If the sound power is doubled to 2 Watts, what will the sound power level be?
[3 marks]
- c) When measured at the same location, four noise sources have sound pressure levels of 89, 87, 78 and 81 dB respectively. What should the sound pressure level at this location be if all four sources were running concurrently?
[5 marks]
- d) Use the following results to carry out an audiogram evaluation.

Frequency (Hz)	Baseline Audiogram Threshold (dB)	Annual Audiogram Threshold (dB)	Change
500	5	5	
1000	5	5	
2000	0	10	
3000	5	20	
4000	10	35	
6000	10	15	

Calculate the Standard Threshold Shift (STS) and stipulate your conclusion.

[6 marks]

QUESTION 4.

Describe the components of an effective hearing conservation program.

[20 marks]

QUESTION 5

- i) A 5 m x 10 m x 3.4 m room has a 10-microwatt ($1 \mu\text{W} = 10^{-6}$ 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 $\alpha = 0.26$. 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.
- ii) A 2.4m x 6m, 10.2cm thick brick wall has 0.3175cm thick 0.9m x 1.5m window in it.

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

- i) Compute the normal incidence transmission loss for the brick wall and windows individually and at a frequency of 500 Hz.
- ii) Compute the normal incidence transmission loss of the composite barrier composed of the brick wall and two windows.

QUESTION 6

- a) Two sources of different frequencies 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 $L_{EP,d}$ (Equivalent continuous level per day) 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]