UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCES

MAIN EXAMINATION, DECEMBER, 2016

TITLE OF PAPER : **ACOUSTICS AND HEALTH**

COURSE CODE : **EHM 401**

TIME : **2HOURS**

TOTAL MARKS : **100**

INSTRUCTIONS:

1. **QUESTION 1 IS COMPULSORY**
2. **ANSWER ANY OTHER THREE QUESTIONS**
3. **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
4. **FORMULAE AND PERIODIC TABLE ARE PROVIDED**
5. **BEGIN THE ANSWER TO EACH QUESTION IN A SEPARATE SHEET OF PAPER.**

DO NO OPEN THIS EXAMINATION PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR.

QUESTION 1

I. Write True or False against each letter corresponding to the following statements as they apply to acoustics and health.

a) When sound spreads out from a point source in a free space, the wave fronts are spherical and the sound pressure level will decrease 3 dB for each doubling of distance.

b) For equipment used in-doors, attenuation depends on the sound absorptive properties of room surfaces, room geometry and the scattering of sound by objects in the room.

c) The word sound is used to describe an auditory sensation in the ear and the disturbance in a medium which can cause this sensation.

d) When a sound wave strikes an obstacle, part of it is reflected, part is absorbed within the obstacle and part is transmitted through to become a sound wave in air again on the other side.

e) White noise is noise having frequencies unevenly distributed throughout the audible range, and it sounds rather like rushing water.

f) Most sounds encountered in noise control problems are continuous spectrum sounds in which acoustic energy is not distributed over the whole range of audible frequencies.

g) Assessment of noise exposure involves carrying out of a noise survey in which the exposures of individual employees are obtained.

h) The pressure changes produced by a sound wave are known as the sound pressure.

i) Noise is damaging sound, that is, sound which interferes with what people are trying to do, or sound which has an adverse effect on health or safety.

j) Sound with a frequency below 20 Hz is called ultrasound.

(20 marks)

II. Describe the purpose of a detailed noise survey.

(5 marks)

QUESTION 2

Describe Hearing Conservation Programs under the following headings:

a) Main components of such programs

(4 marks)

b) Sound survey

5 marks)

c) Engineering and Administrative Controls

(8 marks)

d) Hearing Protection Devices:

i. Types and how they achieve protection of users

ii. Attenuation Rating

(8 marks)

QUESTION 3

a) Describe the effects of noise exposure under the following headings:

i) Temporary threshold shift

(3 marks)

ii) Permanent threshold shift

(3 marks)

b) The sound pressures of the sound propagating in a duct were measured in the indicated areas and were found to be:
$P_{rms}(1) = 2.25 \times 10^{-2}$ Pa $P_{rms}(2) = 2.42 \times 10^{-2}$ Pa
$P_{rms}(3) = 1.82 \times 10^{-2}$ Pa $P_{rms}(4) = 1.94 \times 10^{-2}$ Pa
The dimensions of areas 1, 2, 3 and 4 of the duct are 0. 8m x 0.8m each.

1	2
3	4

Determine the acoustic sound power of the sound that is propagating in the duct.

N.B: $W = \sum_{i=1}^{4} \frac{p^{2rms(1)} S_i}{\rho C}$, where $\rho C = 420$ RAYLS.

(4 marks)

c) If a pure tone acoustic wave has a S.I.L of 90dB what is the peak value of acoustic pressure?

(5 marks)

d) A 5 m x 10 m x 3m room has a 1 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 $\alpha = 0.26$.
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)

QUESTION 4

a) Describe noise enclosures under the following headings:
i. Their function(s)

(5 marks)

FORMULAE- ACOUSTIC AND HEALTH

1. $W = \sum_{i=1}^{4} \frac{p\ rms(I)S}{\rho C}$ where ρC = 420 RAYLS
2. SPL = 10 log $(p_1/p_0)^2$
3. NR= 10 $\log_{10}$ = $\frac{TA_2}{TA_1}$
4. SPL_t= 10 log $_{10}$ [Σ $10^{SPL/10}$]
5. SWL= 10 log W/W_0
6. $I = \frac{W}{A}$
7. $I = \frac{p^2_{rms}}{\rho C}$ or $p_{rms} = (I \rho C)^{1/2}$
8. S.I.L = 10 $\log_{10}$ (I/I_{ref})
9. $R = \frac{S\bar{\alpha}}{1-\bar{\alpha}}$
10. $\bar{\alpha} = \frac{S_i\bar{\alpha}_i + S_2\bar{\alpha}_2 + \ldots.}{S_i + S_2}$
11. $SPL_t = SWL + 10 \log_{10} \{ \frac{Q}{4\pi r^2} + \frac{4}{R} \}$
12. $T = \frac{0.161\ V}{S\bar{\alpha}}$
13. $T = \frac{0.161\ V}{-S[\ln(1-\bar{\alpha})] + 4mV}$
14. $\tau = \frac{p_t^2/\rho C^2}{p_i^2/\rho C^2}$
15. TL= 10 log $_{10}$ $[\frac{1}{\tau}]$
16. $t = \frac{1}{1.21 \times 10^{-4}\ yr^{-1}} \ln(\frac{0.227}{s})$
17. Radiation Intensity $\propto \frac{1}{d^2}$