UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

BSc IN ENVIRONMENTAL HEALTH SCIENCE

DEGREE IN ENVIRONMENTAL HEALTH SCIENCES

(MAIN EXAMINATION, DECEMBER, 2015)

TITLE OF PAPER : **ACOUSTICS AND HEALTH**

COURSE CODE : **EHM 401**

TIME : **2 HOURS**

TOTAL MARKS : **100**

INSTRUCTIONS:

- **QUESTION 1 IS COMPULSORY**
- **ANSWER ANY OTHER THREE QUESTIONS**
- **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
- **FORMULAE AND OTHER DATA IS PROVIDED**
- **NO FORM OF PAPER SHOULD BE BROUGHT IN OR OUT OF THE EXAMINATION ROOM**
- **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

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

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

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

i) Temporary threshold shift

(3 marks)

ii) Permanent threshold shift

(5 marks)

iii) Noise-induced hearing loss

(5 marks)

b) The sound pressures of the sound propagating in a duct were measured in the indicated areas and were found to be:

$P_{rms}(1) = 2.12 \times 10^{-2}$ Pa $\qquad$ $P_{rms}(2) = 2.1 \times 10^{-2}$ Pa

$P_{rms}(3) = 1.92 \times 10^{-2}$ Pa $\qquad$ $P_{rms}(4) = 1.8 \times 10^{-2}$ Pa

The dimensions of areas 1, 2, 3 and 4 of the duct are 0.7m x 0.7m each.

1	2
3	4

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

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

(5 marks)

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

(7 marks)

QUESTION 3

a) A simple spherical sound source radiates sound into whole space with 1acoustic watts of power at frequency of 600 Hz. Find the acoustic intensity and sound pressure at radial distances of 1m and 2m from the source.

(12 marks)

b) Two sound sources are radiating sound waves of different frequencies and the individual sound pressure levels recorded are 88 and 85dB. Determine the total sound pressure level.

(5 marks)

c) The background sound pressure level at a point is 75 dB. Sound from a fan increases this to 78 dB. What would be the sound pressure level due to the fan alone?

(8 marks)

QUESTION 4

a) A 2.4m x 6m, 10.2cm thick brick wall has one 0.3175cm thick 0.9m x 1.5m window in it.

NB: The specific surface density for the brick is 21kg/m^2/cm and for glass are 24.7 kg/m^2/cm.

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

(8 marks)

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

(4 marks)

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

84 dBA for 2 hours

87 dBA for 3 hours

90 dBA for 0.5 hours

Determine the daily personal exposure ($L_{Ep,d}$) for this individual.

(6 marks)

c) Describe the main elements of the Noise at Work Regulations.

(7 marks)

QUESTION 5

a) A 6m x 9m x 5m room has a 10-microwatt ($1\mu W = 10\ m^6$ watts) sound source located in the centre of the 6m wall where the floor and wall meet. The absorption coefficients associated with the room are:

Wall: $\alpha = 0.02$;

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.

(18 marks)

b) An office is separated by a partition wall of area 100 m^2 having a sound reduction index of 40 dB. A door of area 2.5 m^2 having a sound reduction index of 30 dB is added to the partition. If the room adjoining the office has sound pressure level of 75 dB, find the sound pressure level in the office when the door is closed and when it is open

(7 marks)

FORMULAE- ACOUSTIC AND HEALTH

1. $W = \sum_{i=1}^{4} \frac{p^{2rms(1)} S_i}{\rho C}$, where $\rho C = 420$ RAYLS.
2. $L_p = 10 \log (p_1/p_0)^2$
3. $NR = 10 \log_{10} = \frac{TA_2}{TA_1}$
4. $SPL_t = 10 \log_{10} [\Sigma 10^{SPL/10}]$
5. $L_W = 10 \log W/W_0$
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. $R = \frac{S\bar{\alpha}}{1-\bar{\alpha}} = \frac{19.8}{} = 22.10$
10. $\bar{\alpha} = \frac{S_1\bar{\alpha}_1 + S_2 \bar{\alpha}_2 + \ldots.}{S_1 + S_2}$
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. $TL_{brick} = 10 \log_{10} \{ \frac{1}{\tau} \}$