UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES
DEPARTMENT OF ENVIRONMENTAL HEALTH
BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCES
MAIN EXAMINATION, DECEMBER, 2017

TITLE OF PAPER : **ACOUSTICS AND HEALTH**

COURSE CODE : **EHM 401**

TIME : **2HOURS**

TOTAL MARKS : **100**

INSTRUCTIONS:

- **QUESTION 1 IS COMPULSORY**
- **ANSWER ANY OTHER THREE QUESTIONS**
- **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
- **FORMULAE AND PERIODIC TABLE ARE PROVIDED**
- **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.

a) Noise control measures are required to be implemented according to the hierarchy of controls so far as reasonably practicable.

b) Noise control measures cannot be included in the design of installation areas and the design of and construction of new workplaces.

c) Noise assessments should be repeated at least every five years or whenever there is a change of plant, work processes, building structure or duration of work arrangements.

d) Personal hearing protectors should not be used as a substitute for engineering or administrative noise control measures.

e) No person, including visitors, managers or supervisors, should enter a hearing protection area during normal operation unless they wear appropriate personal hearing protectors, regardless of how long the person spends in the hearing protection area.

f) An Integrated Sound Level Meter is similar to a dosimeter in that it can be used to measure equivalent noise level averaged over the measurement period.

g) The reverberant field is due to the noise radiating directly from the source.

h) At any instance, the distance of a particle from its mean position is known as the particle displacement.

i) Sound power is the force per unit area and it gives the magnitude of the wave.

j) When sound spreads out from a plane source, the wave fronts are perpendicular to the direction of propagation and the sound pressure level does not increase with distance.

k) The sound intensity at a point in the surrounding medium is the power passing through a unit area.

l) Sound power is a fundamental property of a source and is not affected by the surroundings

(24 marks)

II.

What is a sound with a frequency above 20 000 Hertz called?

(1 marks)

QUESTION 2

a) Describe noise monitoring using a noise dosimeter

(10 marks)

b) Describe the purpose of a detailed noise survey.

(4 marks)

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

85 dB(A) for 3.75 hours
90 dB(A) for 2 hours
94 dB(A) for 2 hours
95 dB(A) for 0.25 hours

Calculate the daily dose and give your conclusion about the exposure of this worker.
N.B. The permissible noise exposures are as follows:

Duration per day (hours)	**Sound level (dBA)**
8	90
6	92
4	95
$1\frac{1}{2}$	102
1	105
$\frac{1}{2}$	110
$\frac{1}{4}$	115

(6 marks)

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

$P_{rms}(1) = 1.25 \times 10^{-2}$ Pa $P_{rms}(2) = 1.52 \times 10^{-2}$ Pa

$P_{rms}(3) = 1.82 \times 10^{-2}$ Pa $P_{rms}(4) = 1.97 \times 10^{-2}$ 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: $W = \sum_{i=1}^{4} \frac{p^{2rms(1)} S_i}{\rho C}$, where $\rho C = 420$ RAYLS.

(5 marks)

QUESTION 3

a) Describe a noise survey

(6 marks)

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

i) Temporary threshold shift

(3 marks)

ii) Permanent threshold shift

(3 marks)

c) If a pure tone acoustic wave has a S.I.L of 93dB what is the peak value of acoustic pressure?

(5 marks)

a) A 6 m x 10 m x 4m room has a 10 microwatt (1 μW= 10^{-6} watts) sound source located in the centre of the 6 m wall where the floor and the wall meet. The absorption coefficients associated with the room are: walls $\alpha = 0.15$, floor $\alpha = 0.12$ and ceiling $\alpha = 0.18$.
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.

(8 marks)

QUESTION 4

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

(5 marks)

   ii. Types of enclosures

(15 marks)

b) A reverberant enclosure 8m long, 5m wide and 3m high, has an average absorption coefficient of 0.02. What is the reverberation time of the enclosure?

(5 marks)

QUESTION 5

a) Describe three primary reasons for reducing noise levels in an occupational environment.

(12 marks)

b) A 1.5m x 6m door is located in a 3m x 8m wall. The door has a sound reduction index of 15dB while that of the wall is 25dB.
Determine the sound reduction index of the combination.

(5 marks)

c) When measured at the same location, four noise sources have sound pressure levels of 89, 97, 78 and 81 dB respectively. What would the sound pressure level at this location be if all four sources were running concurrently?

(8 marks)

FORMULAE- ACOUSTIC AND HEALTH/RADIOACTIVITY AND RADIATION

1. $W = \sum_{i=1}^{4} \frac{p\,rms(I)S}{\rho C}$ where $\rho C = 420$ RAYLS
2. $SPL = 10 \log (p_1/p_0)^2$
3. $NR = 10 \log_{10} = \frac{TA_2}{TA_1}$
4. $SPL_t = 10 \log_{10} [\Sigma\, 10^{SPL/10}]$
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 $\propto \frac{1}{d^2}$