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 1

COURSE CODE   : EHS 569

TIME   : 3 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) Most sounds encountered in noise control problems are continuous spectrum sounds in which acoustic energy is distributed over the whole range of audible frequencies.

b) The characteristic of an octave band is such that the upper frequency limit is thrice the lower limit, and the audible range is then represented by 10 contiguous bands.

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

d) 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.

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

f) Noise-induced hearing loss involves damage to the cochlea.

g) The organ of Corti is the centre of the sense of hearing.

h) Frequency is the number of vibration cycles per second.

i) Sound with a frequency above 20 000 Hz is called infrasound.

j) In audiometry, the further a person's threshold is below the zero line of the audiogram, the lesser is the loss of hearing.

k) For occupational hygiene purposes, the sound pressure level is measured to determine noise exposure.

(22 marks)

II. Define wave velocity

(3 marks)

QUESTION 2

a) The sound pressures of the sound propagating in a duct were measured in the indicated areas and were found to be:
$P_{rms}(1) = 3.2 \times 10^{-2}$ Pa $P_{rms}(2) = 4.0 \times 10^{-2}$ Pa

$P_{rms}(3) = 2.52 \times 10^{-2}$ Pa $\quad$ $P_{rms}(4) = 2.82 \times 10^{-2}$ Pa

The dimensions of areas 1, 2, 3 and 4 of the duct are 0.5m x 0.5m each.

1	2
3	4

1

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

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

(5 marks)

b) An octave band analysis of the noise present within a sports hall is given below. Determine the overall sound pressure level of the noise in dBA.

O/B centre frequency	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1kHz	2 kHz	4 k Hz	8 kHz
O/B SPL(A)dB	84	73	60	58	55	50	45	40	32
"A" weight(B)dB	-40	-26	-16	-9	-3	0	+1	+1	-1

(13 marks)

c) If a pure tone acoustic wave has a S.I.L of 95dB what is the peak value of acoustic pressure?

(7 marks)

QUESTION 3

a) A simple spherical sound source radiates sound into whole space with 1 acoustic 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) The 1/1 octave band sound pressure levels of the noise from a garbage disposal are given below. Determine the overall noise level of the garbage disposal.

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Sound Pressure Level (dB)	70	81	75	65	53	48	47	46

(13 marks)

b) If an axial flow fan emits 1 watt acoustic noise, what is its sound power 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?

(7 marks)

QUESTION 5

a) A hydraulic pump driven by a 2kW electric motor has a sound power level of 90 dB. What percentage of the electrical energy consumed by the pump is emitted as noise?

(6 marks)

b) Describe the hearing process.

(10 marks)

c) When measured at the same location four noise sources have sound pressure levels of 89, 87, 78, and 81 dB, respectively. What would the sound pressure level at this location be if all four sources were running concurrently?

(9 marks)

FORMULAE- ACOUSTIC AND HEALTH

1. $W = \sum\limits_{i=1}^{4} \dfrac{p^{2rms(1)}S_i}{\rho C}$, where $\rho C = 420$ RAYLS.

2. $L_p = 10 \log (p_1/p_0)^2$

3. $NR = 10 \log_{10} = \dfrac{TA_2}{TA_1}$

4. $SPL_t = 10 \log_{10} [\sum 10^{SPL/10}]$

5. $L_W = 10 \log W/W_0$

6. $I = \dfrac{W}{A}$

7. $I = \dfrac{p^2_{rms}}{\rho C}$ or $p_{rms} = (I \rho C)^{1/2}$

8. $S.I.L = 10 \log_{10} (I/I_{ref})$

9. $R = \dfrac{S\bar{\alpha}}{1-\bar{\alpha}} = \dfrac{19.8}{} = 22.10$

10. $\bar{\alpha} = \dfrac{S_i\bar{\alpha}_i + S_2 \bar{\alpha}_2 + \ldots}{S_i + S_2}$

11. $SPL_t = SWL + 10 \log_{10} \{ \dfrac{Q}{4\pi r^2} + \dfrac{4}{R} \}$

12. $T = \dfrac{0.161 \, V}{S \, \bar{\alpha}}$

13. $T = \dfrac{0.161 \, V}{- S [\ln (1- \bar{\alpha})] + 4mV}$

14. $\tau = \dfrac{p_t^2/\rho C^2}{p_i^2/\rho C^2}$

15. $TL_{brick} = 10 \log_{10} \{ \dfrac{1}{\tau} \}$