UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES
DEPARTMENT OF ENVIRONMENTAL HEALTH
BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCES
MAIN EXAMINATION, DECEMBER, 2018

TITLE OF PAPER : **ACOUSTICS AND HEALTH**

COURSE CODE : **EHS 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 and health.

a) At greater distances, sound levels will remain constant regardless of additional distance from the source; this area is defined as the reverberant field.

b) The sound level in the direct field depends on the sound power level of the sound source and the amount of sound absorption in the room.

c) Sound is a disturbance that propagates as a wave of compressions and rarefactions through an elastic medium.

d) In the hierarchy of noise control measures, administrative controls are the highest in terms of implementation of controls.

e) Octave-band sound level data are necessary for designing noise control treatments.

f) Areas where people may be exposed to excessive noise should be signposted as "hearing protection areas" at every entry point to areas and their boundaries should be clearly defined.

g) The Integrated Sound Level Meter cannot be used to measure equivalent noise level averaged over the measurement period,

h) The function of the hearing mechanism is to gather, transmit and perceive sounds from the environment.

i) The translation of acoustic energy into perceptions involves the conversion of sound pressure waves first into electrochemical activity in the inner ear and then into mechanical vibrations.

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

k) A source that emits power equally in all directions is called an omnidirectional source.

l) As the distance from the source increases, the sound intensity increases according to the inverse square law

(24 marks)

II,
What is a sound with one frequency called?

(1 marks)

QUESTION 2

a) Differentiate between air-conduction and bone-conduction.

(6 marks)

b) Describe the types of hearing loss.

(11 marks)

c) Two sound sources are radiating sound waves of different frequencies and the individual sound pressure levels recorded are 75 and 80dB. Determine the total sound pressure level.

(8 marks)

QUESTION 3

a) The background sound pressure level at a point is 65dB. Sound from a fan increases this to 78dB. What would be the sound pressure level due to the fan alone?

(8 marks)

b) 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.

Freuency	Hz	63	125	250	500	1000	2000	4000	8000
Sound Pressure level	dB	64	85	70	60	56	53	53	50

(10marks)

c) Describe how noise problems can be identified at the workplace.

(7 marks)

QUESTION 4

a) A 1.5m x 6m door is located in a 4m x 6m wall. The door has a sound reduction index of 10dB while that of the wall is 15dB.Determine the sound reduction index of the combination.

(6 marks)

b) Noise exposures must be controlled whenever they exceed government or company noise requirements. Usually the best first step to reduce noise is to develop a written noise control plan. Describe the elements of such a plan.

(5 marks)

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

84 dBA for 2 hours
87 dBA for 3 hours
90dBA for 0.5hours

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

(6 marks)

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

(8 marks)

QUESTION 5

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

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

1	2
3	4

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)

b) A simple spherical sound source radiates sound into whole space with 10 acoustic watts of power at frequency of 700 Hz. Find the acoustic intensity and sound pressure at radial distances of 1m and 2m from the source.

(8 marks)

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

(6 marks)

d) 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)

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. $SPL_t = SWL + 10 \log_{10} \{ \frac{Q}{4\pi} 2 + \frac{4}{R} \}$
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 $\propto \frac{1}{d^2}$