UNIVERSITY OF ESWATINI

FACULTY OF HEALTH SCIENCES
DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCE
BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCE
MAIN EXAMINATION, DECEMBER, 2019

TITLE OF PAPER   : ACOUSTICS AND HEALTH

COURSE CODE   : EHS 401

TIME   : 2 HOURS

TOTAL MARKS   : 100

INSTRUCTIONS:

1. QUESTION 1 IS COMPULSORY

2. ANSWER ANY OTHER THREE QUESTIONS

3. ALL QUESTIONS ARE WORTH 25 MARKS EACH

4. BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

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

QUESTION 1

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

a) If the wavelength of the sound is small in comparison with the size of an obstacle, the sound is reflected or scattered in many directions.

b) The two branches of the stapes, anterior and posterior, end in the foot-plate that fits into the oval window.

c) There is no essential physical difference between the sonic and vibratory forms of sound energy.

d) The primary function of the middle ear in the hearing process is to transfer sound energy from the inner ear to the outer ear.

e) When disease is confined in the outer ear and middle ear, the resulting hearing loss is conductive.

f) When hearing thresholds are measured, essentially it is a person's ability to hear pure tones that is being measured.

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

h) In a homogenous medium, the speed of sound is independent of frequency.

i) If the person hears just as poorly by bone conduction as by air conduction, then the hearing loss can be due to damage to the deep structures of the ear.

j) Permanent Threshold Shift is the greatest immediately after exposure to excessive noise and progressively diminishes with increasing rest time as the ear recovers from the apparent noise over stimulation.

k) Sound is any pressure variation, in air, water or some other medium that the human ear can detect.

(22 marks)

II. Name three most important risk factors that affect the degree and extent of hearing loss.

(3 marks)

QUESTION 2

a) Describe an audiogram and how it is used in determining hearing loss

(12 marks)

b) Describe the important variables in the development of temporary and permanent hearing threshold changes.

(6 marks)

c) Describe Communication Problems: Hearing versus Understanding

(7 marks)

QUESTION 3

a) Describe the two types of hearing loss

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

$P_{rms}(3) = 1.92 \times 10^{-2}$ Pa $P_{rms}(4) = 1.8 \times 10^{-2}$ 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: $\quad W = \overset{4}{\underset{I=1}{\Sigma}} \dfrac{p^{2rms(1)}S_i}{\rho C}$, where $\rho C = 420$ RAYLS.

(5 marks)

c) 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	83	69	56	55	50	50	49

(12 marks)

QUESTION 4

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?

(7 marks)

b) A 3m x 5m door is located in a 15m x 8m 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.

(7 marks)

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

  86 dBA for 1.5hours

  88 dBA for 2hours

  93 dBA for 1hour

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

(7 marks)

d) What is the frequency of the predominant tone that would be emitted from an axial fan with four blades rotating at 3 000 rpm?

(4 marks)

QUESTION 5

    i.   Describe how a noise survey is carried out.

(10 marks)

    ii.   Describe the four classes of hearing protectors

(12 marks)

    iii.   Describe the purpose of an assessment of noise exposure

(3 marks)

FORMULAE:

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. $\bar{\alpha} = \frac{S_i\bar{\alpha}_i + S_2 \bar{\alpha}_2 + ...}{S_i + S_2}$

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 $\propto \frac{1}{d^2}$