UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES
DEPARTMENT OF ENVIRONMENTAL HEALTH
BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCES
SUPPLEMENTARY EXAMINATION, JANUARY, 2019

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 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-induced hearing loss involves damage to the cochlea.
b) The organ of Corti is the centre of the sense of hearing.
c) Frequency is the number of vibration cycles per second.

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

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

f) Refraction occurs when an obstacle's dimensions are larger than the wavelength of the sound.

g) Diffraction occurs when an obstacle's dimensions are of the same order or less than the wavelength of the sound

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

i) The incidence of noise-induced hearing loss is directly related to total exposure time.

j) 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.

(20 Marks)

II.

Show that the ratio of the acoustic powers of two sounds expressed in dB is equal to the difference of their power levels.

(5 marks)

QUESTION 2

i. Describe the following noise control measurements as applied in Acoustics and health.

a) Administrative controls

(3 marks)

b) Engineering controls

(6 marks)

ii. Describe measurement of workplace noise under the following headings:

a) Why measure noise

(2 marks)

b) How is workplace noise measured

(2 marks)

c) How noise problems are identified in the workplace

(4 marks)

d) Types of instruments used for measuring noise and the appropriate measurement each instrument is used for.

(8 marks)

QUESTION 3

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) Describe the communication problems of people with noise-induced hearing loss under the following headings:

i. Hearing versus understanding.
ii. Loudness
iii. Clarity
iv. Speech sound

(12 marks)

QUESTION 4

a) Describe the five (5) primary reasons for reducing noise levels in an occupational environment.

(15 marks)

b) 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.

(10 marks)

QUESTION 5

a) 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

(9 marks)

b) Sound waves of sound power level 70 dB are incident on a concrete wall. Assuming 1/10000 of the incident energy is transmitted through the wall, find the sound reduction index of the wall and the reduced sound power level.

(4 marks)

c) A 2.4m x 6m, 10.2cm thick brick wall has one 0.3175cm thick 0.9m x 1.5m windows 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)

FORMULAE- ACOUSTIC AND HEALTH

1. $W = \sum_{i=1}^{4} \frac{p^2_{rms}(1)S_i}{\rho C}$, 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. $\bar{\alpha} = \frac{S_i \bar{\alpha}_i + S_2 \bar{\alpha}_2 + \ldots.}{S_i + S_2}$
11. $SPLt = SWL + 10 \log_{10} \{ \frac{Q}{4\pi r^2} + \frac{4}{R} \}$
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. $TL_{brick} = 10 \log_{10} \{ \frac{1}{T} \}$
16. $L_p = 10 \log (p_1/p_0)^2$ Or $(p_1/p_0)^2 = 10^{Lp/10}$
17. $SPL_t = 10 \log_{10} [\Sigma 10^{SPL/10}]$
18. $kr = \frac{2\pi f r}{C}$
19. $I = \frac{p^2_{rms}}{\rho_0 C}$
20. $I = p^2_{max}/2 \rho C$