UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCES

SUPPLEMENTARYEXAMINATION, JULY, 2017

TITLE OF PAPER   : ACOUSTICS AND HEALTH

COURSE CODE   : EHM 401

TIME   : 2HOURS

TOTAL MARKS   : 100

INSTRUCTIONS:

1. QUESTION 1 IS COMPULSORY

2. ANSWER ANY OTHER THREE QUESTIONS

3. ALL QUESTIONS ARE WORTH 25 MARKS EACH

4. FORMULAE AND PERIODIC TABLE ARE PROVIDED

5. 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. **Multiple choices: for the following statements as applied in acoustics and health, write whether they are True or False.**

    (a) Prolonged exposure to high noise levels may have physiological effects such as significant hearing loss caused by the atrophy of hair cells in the inner ear.

    (b) The technological challenges to controlling noise in the workplace include (i) using available technology to solve as many of the problems of excessive noise as possible (ii) developing new technology for addressing the remaining problems

    (c) Theoretically, sound waves outdoors spread geometrically at a rate of 3 dB per doubling of distance.

    (d) For equipment used in-doors, attenuation depends on the sound absorptive properties of room surfaces, room geometry and the scattering of sound by objects in the room.

    (e) The psychological effects of noise include; annoyance, sleep disturbance, interference with communication and adverse effects on hearing, social behavior, job performance and safety.

    (f) Assessment of noise exposure involves carrying out of a noise survey in which the exposure of individual employees is obtained.

    (g) For occupational hygiene purposes, the sound power level is measured to determine noise exposures.

    (h) For personal noise exposure measurement, the Integrated Sound Level Meter is the most accurate.

    (i) The rate of decay of sound within a room is independent of the rate at which energy is extracted from the sound waves by the absorbent boundaries.

    (j) When a sound wave strikes an obstacle, part of it is reflected, part is absorbed within the obstacle and part is transmitted through to become a sound wave in air again on the other side.

(20 marks)

II.

Briefly describe noise the Integrated Sound Level Meter and its functioning.

(5 marks)

QUESTION 2

I.   Describe Hearing Conservation Programs under the following headings:

        a) Audiometric testing

(4 marks)

        b) Employee education and training

(6 marks)

        c) Record keeping

(4 marks)

        d) Program evaluation

(11marks)

QUESTION 3

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)

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

(9 marks)

QUESTION 4

a) 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)

b) With the aid of a diagram of an ear, describe the hearing process and how noise could affect the ear.

(10 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.

(5 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

(8 marks)

b) 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 $21 kg/m^2/cm$ 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.

(6 marks)

ii) Compute the normal incidence transmission loss of the composite barrier composed of the brick wall and two windows.

(4 marks)

c) Find the Noise Reduction if material with a coefficient of absorption of 0,6 was added to the ceiling of the room in **Question 4 a)** above.

(7 marks)

FORMULAE- ACOUSTIC AND HEALTH

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 $= 10 \log_{10} = \dfrac{TA_2}{TA_1}$

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

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

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

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

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

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 $= 10 \log_{10} [\frac{1}{\tau}]$

16. $t = \dfrac{1}{1.21 \times 10^{-4}\,yr^{-1}} \ln(\frac{0.227}{s})$

17. Radiation Intensity $\propto \dfrac{1}{d^2}$