UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Science

DEGREE IN ENVIRONMENTAL HEALTH SCIENCES

FINAL EXAMINATION PAPER 2016

TITLE OF PAPER : ACOUSTICS AND HEALTH II

COURSE CODE : EHS 570

DURATION : 3 HOURS

MARKS : 100

INSTRUCTIONS
: READ THE QUESTIONS & INSTRUCTIONS CAREFULLY
: QUESTION 1 IS COMPULSORY
ANSWER **ANY OTHER THREE** QUESTIONS
: EACH QUESTION **CARRIES 25** MARKS.
: WRITE NEATLY & CLEARLY
: NO PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM.
: BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY THE INVIGILATOR.

QUESTION 1

Write True or False against each letter corresponding to the following statements as they apply to acoustics.

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

(b) The first step in identifying noise problems in the workplace is to determine whether or not noise is a potential problem in the workplace.

(c) When a noise source is located in any environment, other than free field, the sound pressure level at any point will depend on the sound power level, the directivity factor and the sound energy reflected back into the field by the surrounding walls of the environment.

(d) The Noise Reduction coefficient is the arithmetic average of absorption coefficients in the four octave bands 125 Hz and 2000 Hz

(e) The effects of noise can be both psychological and physiological and can lead to a decrease in working efficiency and in some cases present a safety risk.

(f) The risk of hearing loss from high noise environments depends on both the level of noise and the length of time an individual is exposed to that level.

(g) The sound power level is independent of the room constant, R, and the sound can be reduced by adding sound absorption to the enclosure.

(h) Where the noise level fluctuates, as it happens in most industrial situations, the concept of the equivalent continuous sound level is used.

(i) A noise dosimeter is a small, light device that stores the noise level information and carries out an averaging process.

(j) The reverberation time is the time taken for the intensity of a sound to be reduced to tone billionth of the level existing when the source was switched off.

[20 marks]

II.

Briefly describe a sound level meter and its functions.

[5 marks]

QUESTION 2

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

a) Administrative controls

[3 marks]

b) Engineering controls

[8 marks]

c) Reduce driving force

[5 marks]

d) Reduce response of vibrating force

[5 marks]

e) Reduce radiation efficiency by reducing area of vibrating surface

[4 marks]

QUESTION 3

a) Describe measurement of workplace noise under the following headings:

i. Why measure noise

[2 marks]

ii. How is workplace noise measured

[2 marks]

iii. How noise problems are identified in the workplace

[4 marks]

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

[8 marks]

b) A 5 m x 10 m x 3m room has a 1 microwatt (1 $\mu W = 10^{-6}$ watts) sound source located in the centre of the 5 m wall where the floor and the wall meet. The absorption coefficients associated with the room are: walls $\alpha = 0.02$, 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.

[9 marks]

QUESTION 4

a) A 2.4m x 6m, 10.2cm thick brick wall has two 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.

[6 marks]

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

[4marks]

b) 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

[5 marks]

c) 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.

[5 marks]

d) 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.

[5 marks]

QUESTION 5

a)

i. A 1.5m x 6m door is located in a 3m x 8m wall. The door has a sound reduction index of 15dB while that of the wall is 25dB.
Determine the sound reduction index of the combination.

[5 marks]

ii. A wall 15m x 25m with an initial sound reduction index of 50dB has three (3) windows built into it. The area of each window is 5m^2 and its sound transmission coefficient is 0.01. Determine the new sound reduction index of the wall with windows.

[6 marks]

iii. Determine the reverberant tunes. T, for rooms, 5m x 10m x 3.5m with the following characteristics:

i) $\alpha = 0.1$, $S = 205m^3$, $V = 175m^3$
ii) $\alpha = 0.25$, $S = 205m^3$, $V = 175\ m^3$

[4 marks]

b) Describe the elements of the basic plan for determining compliance with Occupational Safety and Health Administration noise survey.

[10 marks]

FORMULAE- ACOUSTIC AND HEALTH

1. $W = \sum_{i=1}^{4} \frac{p^{2rms(1)} S_i}{\rho C}$, where $\rho C = 420$ RAYLS.
2. $L_p = 10 \log (p_1/p_0)^2$
3. $NR = 10 \log_{10} = \frac{TA_2}{TA_1}$
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. $SPL_t = SWL + 10 \log_{10} \{ \frac{Q}{4\pi r^2} + \frac{4}{R} \}$
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. $TL_{brick} = 10 \log_{10} \{ \frac{1}{\tau} \}$