UNIVERSITY OF SWAZILAND
FACULTY OF HEALTH SCIENCES
BSc IN ENVIRONMENTAL HEALTH SCIENCE
(FINAL EXAMINATION)

TITLE OF PAPER : ACOUSTICS AND HEALTH II

COURSE CODE : EHS 570

TIME : 3HOURS

TOTAL MARKS : 100

INSTRUCTIONS:

- QUESTION ONE IS COMPULSORY
- ANSWER ANY OTHER THREE QUESTIONS
- ALL QUESTIONS ARE WORTH 25 MARKS EACH
- FORMULAE AND OTHER DATA IS PROVIDED
- NO FORM OF PAPER SHOULD BE BROUGHT IN OR OUT OF THE EXAMINATION ROOM
- 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 choice: Write True or False against each letter corresponding to the following statements as they apply to acoustics.

(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 control 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 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) 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
90 dBA for 0.5 hours

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 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. $I = p^2_{max}/2\, \rho C$