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 1 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) The free field environment is necessary in obtaining accurate determination of the sound power level and directivity characteristics of the source.

b) When a sound wave strikes a surface some of the power is reflected and some absorbed.

c) If the noise level is steady throughout the exposure period, then a direct measurement of the A-weighted sound pressure level provides an adequate basis for determining exposure.

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

e) The A-weighted response stimulates the sensitivity of the human ear at high sound levels.

f) Dosimeters can be used to identify specific noise sources.

g) The most significant danger from noise is its inability to damage the sense of hearing.

h) 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, that is, the A-weighted energy dose received by the ear.

i) In the region close to the sound source, the sound pressure level is independent of the room constant, R, and the sound can be reduced by adding sound absorption to the enclosure.

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 the dosimeter and its functions.

(5 marks)

QUESTION 2

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

(25 marks)

QUESTION 3

a) Describe classes of hearing protection under the following headings:
   i. Enclosures
   ii. Aural inserts
   iii. Superaural
   iv. Circumaural

(12 marks)

b) The best first step to reduce noise is to develop a written noise control plan. Describe the components of such a plan.

(10 marks)

c) What is the purpose of noise exposure assessment?

(3 marks)

QUESTION 4

a) 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.

(10 marks)

b) An office is separated by a partition wall of an 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 a sound pressure level of 75 dB, find the sound pressure level in the office when the door is closed.

(5 marks)

c) Describe five (5) essential elements of the Noise at Work Regulations

(10 marks)

QUESTION 5

a) A 2.4m x 6m, 102cm thick brick wall has two 0.3175 thick 0.9m x 1.5m glass window in it.
NB: The specific surface density for the brick is 21 $kg/m^2/cm$ and for glass is 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)

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

(10 marks)

c) A worker in an engineering workshop is exposed to the following noise levels:
87 dBA for 3hours
90 dBA for 2hours
95 dBA for 1.5hours
Determine $L_{EP,d}$ for this individual.

(5 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. $R = \frac{S\square}{1-\square} = \frac{19.8}{} = 22.10$
10. $\square = \frac{S_i \square_i + S_2 \square_2 +}{S_i + S_2} \ldots.$
11. $SPLt = SWL + 10 \log_{10} \{ \frac{Q}{4\pi r^2} + \frac{4}{R} \}$
12. $T = \frac{0.161\ V}{S \square}$
13. $T = \frac{0.161\ V}{- S [\ln (1- \square)] + 4mV}$
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. $I = p^2_{max}/2\ \rho C$