

**FACULTY OF HEALTH SCIENCES  
DEGREE IN ENVIRONMENTAL HEALTH SCIENCES  
(FINAL EXAMINATION)**

**TITLE OF PAPER : ACOUSTICS AND HEALTH 1**  
**COURSE CODE : EHS 569**  
**TIME : 3 HOURS**  
**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

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

**I.**

- a) The room radius is a point where at some distance from the source, the direct and reverberant components are equal.
- b) When a sound wave strikes a surface some of the power is reflected and some absorbed.
- c) Noise is unwanted or damaging sound or sound which has an adverse effect on health.
- d) Sound power is the force per unit area.
- e) Frequency is the number of vibration cycles per second.
- f) Sound with a frequency above 20 000 Hz is called infrasound.
- g) Refraction occurs when an obstacle's dimensions are larger than the wavelength of the sound.
- h) Measuring noise levels and worker's noise exposures helps identify work locations where there are noise problems, employees who may be affected, and where additional noise measurements need to be made.
- i) For occupational hygiene purposes, the sound pressure level is measured to determine noise exposure.
- j) The first step in identifying noise problems in the workplace is to determine whether or not noise is a potential problem in the workplace.

**( 20 marks)**

**II**

Briefly describe a sound level meter and its functions.

**(5 marks)**

## QUESTION 2

a) Describe the effects of noise exposure under the following headings:

- i) Temporary threshold shift
- ii) Permanent threshold shift
- iii) Noise-induced hearing loss

**(3 marks)**

**(5 marks)**

**(5 marks)**

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

i. Why measure noise

(2 marks)

ii. How is workplace noise measured

(3 marks)

iii. Types of instruments used for measuring noise

(7 marks)

### QUESTION 3

a) Describe a hearing conservation program.

(18 marks)

b) Two sound sources are radiating sound waves of different frequencies and the individual sound pressure levels recorded are 88 and 85 dB. Determine the total sound pressure level.

(7marks)

### QUESTION 4

a) The sound pressures of the sound propagating in a duct were measured in the indicated areas and were found to be:

$$P_{rms}(1) = 3.2 \times 10^{-2} \text{ Pa} \quad P_{rms}(2) = 4.0 \times 10^{-2} \text{ Pa}$$

$$P_{rms}(3) = 2.52 \times 10^{-2} \text{ Pa} \quad P_{rms}(4) = 2.82 \times 10^{-2} \text{ Pa}$$

The dimensions of areas 1, 2, 3 and 4 of the duct are 0.5m x 0.5m each.

1	2
3	4

Determine the acoustic sound power of the sound that is propagating in the duct.

N.B:  $W = \sum_{i=1}^4 \frac{p_{rms(i)}^2 S_i}{\rho C}$ , where  $\rho C = 420 \text{ RAYLS}$ .

(5 marks)

b) A simple spherical sound source radiates sound into whole space with 10 acoustic watts of power at frequency of 700 Hz. Find the acoustic intensity and sound pressure at radial distances of 1m and 2m from the source.

(10 marks)

c) Two sound sources are radiating sound waves of different frequencies and the individual sound pressure levels recorded are 88 and 85 dB. Determine the total sound pressure level.

(7marks)

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

( 3 marks)

### QUESTION 5

- a) The 1/1 octave band sound pressure levels of the noise from a garbage disposal are given below. Determine the overall noise level of the garbage disposal.

Freuency	Hz	63	125	250	500	1000	2000	4000	8000
Sound Pressure level	dB	70	81	75	66	56	48	53	50

(13 marks)

- b) Describe the hearing process

( 12 marks)

# FORMULAE- ACOUSTIC AND HEALTH

$$1. W = \sum_{i=1}^4 \frac{p_{rms}^2(1)S_i}{\rho C}, \text{ where } \rho C = 420 \text{ RAYLS.}$$

$$2. L_p = 10 \log (p_1/p_0)^2$$

$$3. NR = 10 \log_{10} = \frac{TA_2}{TA_1}$$

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

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

$$6. I = \frac{W}{A}$$

$$7. I = \frac{p_{rms}^2}{\rho C} \text{ or } p_{rms} = (I \rho C)^{1/2}$$

$$8. S.I.L = 10 \log_{10} (I/I_{ref})$$

$$9. R = \frac{S\bar{\alpha}}{1-\bar{\alpha}}$$

$$10. \bar{\alpha} = \frac{S_1 \bar{\alpha}_1 + S_2 \bar{\alpha}_2 + \dots}{S_1 + S_2}$$

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

$$12. T = \frac{0.161 V}{S \bar{\alpha}}$$

$$13. T = \frac{0.161 V}{-S [\ln (1 - \bar{\alpha})] + 4mV}$$

$$14. \tau = \frac{p_r^2/\rho C^2}{p_i^2/\rho C^2}$$

$$15. TL_{brick} = 10 \log_{10} \left\{ \frac{1}{T} \right\}$$

$$16. L_p = 10 \log (p_1/p_0)^2 \text{ Or } (p_1/p_0)^2 = 10^{L_p/10}$$

$$17. SPL_t = 10 \log_{10} [\sum 10^{SPL/10}]$$

$$18. kr = \frac{2\pi f r}{C}$$

$$19. I = \frac{p_{rms}^2}{\rho_0 C}$$

$$20. I = p_{max}^2/2 \rho C$$