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) Noise is unwanted or damaging sound or sound which has an adverse effect on health.

b) To be able to deal with problems of noise, one must first have an understanding of the nature of sound and its physical properties.

c) The word sound is used to describe an auditory sensation in the ear and the disturbance in a medium which can cause this sensation.

d) The number of power variations per second is called the frequency of the sound and is measured in Hertz.

e) White noise is noise having frequencies unevenly distributed throughout the audible range, and it sounds rather like rushing water.

f) Most sounds encountered in noise control problems are continuous spectrum sounds in which acoustic energy is not distributed over the whole range of audible frequencies.

g) In the formula, $K = - dp/dV/V$, means that a pressure rise, dp, acting on an element of volume, V, produces a dilation or reduction in volume, dV; conversely a pressure rise, dp, acting on the same element produces a condensation or increase in volume, dV.

h) The pressure changes produced by a sound wave are known as the sound pressure.

i) The range audible to young people with undamaged hearing is about 20 Hertz to 20 000 Hertz and for adults 20 to 16 000 Hertz.

j) Sound with a frequency below 20 Hz is called ultrasound.

(20 marks)

II.

If the r.m.s value of acoustic pressure of a plane wave is 6.5 N/m^2 at standard temperature and pressure, what is the sound intensity level of the wave? At standard temperature and pressure, $p = 1.2\ kg/m^2$ and $C = 344$ m/s

(5 marks)

QUESTION 2

a) An octave band analysis of the noise present within a sports hall is given below. Determine the overall sound pressure level of the noise in dBA.

O/B centre frequency	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1kHz	2 kHz	4 k Hz	8 kHz
O/B SPL(A)dB	74	63	50	48	45	40	35	30	22
"A" weight(B)dB	-40	-26	-16	-9	-3	0	+1	+1	-1

(13 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.

(5 marks)

c) If a pure tone acoustic wave has a S.I.L of 95 dB (re 10^{-12} W/m^2) what is the peak value of acoustic pressure?

(7 marks)

QUESTION 3

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

(10 marks)

b) A hydraulic pump driven by a 2kW electric motor has a sound power level of 90 dB.

What percentage of the electrical energy consumed by the pump is emitted as noise?

(6 marks)

c) Two sources are radiating noise in a field. One source has a sound power level of 115 dB and the other source has a sound power level of 105 dB. What is the combined sound power level?

(9 marks)

QUESTION 4

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

$P_{rms}(1) = 2.2 \times 10^{-2}$ Pa $P_{rms}(2) = 3.1 \times 10^{-2}$ Pa

$P_{rms}(3) = 1.95 \times 10^{-2}$ Pa $P_{rms}(4) = 2.5 \times 10^{-2}$ Pa

The dimensions of areas 1, 2, 3 and 4 of the duct are 0.4m x 0.4m each.

1	2
3	4

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

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

(5 marks)

b) 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.

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Sound Pressure Level (dB)	64	83	69	56	55	50	50	49

(13 marks)

c) The background sound pressure level at a point is 56 dB. Sound from a fan increases this to 58 dB. What would be the sound pressure level due to the fan alone?

(7 marks)

QUESTION 5

a) Describe the hearing process and the types of hearing loss.

(15 marks)

b) Suppose the sound pressure level of each of three individual noise sources is measured at a point such that with only the first source running, the sound power level is 89 dB, with only the second running it is 85 dB, and with only the third source running it is 83 dB. What will the sound pressure level at the point be with all three sources running concurrently?

(10 marks)

FORMULAE- ACOUSTICS 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. $\square = \frac{S_i \square_i + S_2 \square_2 + \ldots}{S_i + S_2}$
11. $SPLt = SWL + 10 \log_{10} \{ \frac{Q}{4\pi r^2} + \frac{4}{R} \}$
12. $T = \frac{0.161\ V}{S \square}$
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. $I = p^2_{max}/2 \rho C$