SWAZILAND

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) Sound is a disturbance, or wave which moves through a physical medium from a source to cause the sensation of hearing.

b) The wavelength is the distance between two successive pressure peaks.

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

d) A sound which contains waves of one frequency is called a pure tone.

e) Sound pressure is the energy emitted by a source per unit time.

f) Reflection occurs when a sound ray enters a different medium at an angle and because of the differing speed of travel of the sound wave in the two media, the sound ray will bend.

g) The fraction of sound energy which is absorbed by an obstacle is called its absorption coefficient.

h) Noise is more dangerous when it is concentrated into pure tones or narrow band noise than when it is distributed over a broad band.

i) Narrow band analysers are of two types: constant band-width and constant percentage band-width.

j) The characteristics of an octave band is such that the upper frequency limit is twice the lower limit, and the audible range is then represented by 10 contiguous bands.

(20 marks)

II.

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

(5 marks)

QUESTION 2

a) 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 pressure level is 86 dB, with only the second running it is 84 dB, and with the third source running it is 89 dB. What will be the sound pressure level at the point be with all three sources running concurrently?

(10 marks)

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

(7 marks)

c) Two sources are radiating noise in a free field. One source has a sound power level of 120 dB and the other has a sound power level of 118 dB. What is the combined sound power level of the two sources?

(8 marks)

QUESTION 3

a) 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?

(8 marks)

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

(17 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:
$P_{rms}(1) = 2.25 \times 10^{-2}$ Pa $\quad P_{rms}(2) = 3.52 \times 10^{-2}$ Pa

$P_{rms}(3) = 2.53 \times 10^{-2}$ Pa $\quad P_{rms}(4) = 1.95 \times 10^{-2}$ 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: $W = \sum_{1=1}^{4} \frac{p^{2rms(1)} S_i}{\rho C}$, where $\rho C = 420$ RAYLS.

(5 marks)

b) A simple spherical sound source radiates sound into whole space with 10 acoustic watts of power at frequency of 800 Hz. Find the acoustic intensity and sound pressure at radial distances of 1m and 2m from the source.

(10 marks)

c) If the r.m.s value of acoustic pressure of a plane wave is 8.5 N/m^2 at standard temperature and pressure, what is the sound intensity level of the wave? At S.T.P. $\rho = 1.2$ kg/m^3 and $C = 344$ m/s.

(10 marks)

QUESTION 5

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	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
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

(12 marks)

b) An existing factory installs a new noise source and wishes to assess the likelihood of complaint. The existing and new noise sources will operate only during the day time. The background noise level with the existing plant operating was measured, in this, case for a 30 minute period (40 dB). The new source is continuous and produces a variable level and has a characteristic high-pitched whine. The specific noise level was measured during a temporary shutdown of the factory during which the background noise level fell to 29 dB and the measurement period was sufficiently long for the equivalent continuous level to become steady.

The measurements were as follows: specific noise measurement, (12min) = 39 dB(when background level was 29 dB); Normal background level, (30 min) = 40 dB.

(6 marks)

c) An air conditioning unit operates with a sound intensity level of 73 dB. If it is operated in a room with an ambient sound intensity level of 68 dB, what will be resultant intensity level?

(7marks)

FORMULARS

1. $Cd = 0.61$ and $T = \int dt = \frac{ZA\,(H_1^{1/2} - H_2^{1/2})}{Cda\sqrt{2g}}$

2. $Q = 2/3\ Cd\ \sqrt{2g}\quad b(H_1^{3/2} - H_2^{3/2})$

3. $Y_i = Y_S/2\ (\sqrt{1+8\beta f_S^2} - 1)$

4. $F_S = V_S/\sqrt{gY_S}$

5. $(Y + V/2g) - (Y + V/2g)$

6. $\rho g y^2/2 + \rho q(V_1 - V_2) - \rho g Y_2^2/ F_X = 0$

7. $Y_G = Y_s\ \sqrt{1+2F_s^2}\ (1 - Y_S/ Y_2)$

8. $Q = AV$

9. $Q = A/n\ R^{2/3}\ S_0^{1/2}$

10. $Y_i = Y_S/2\ (\sqrt{1+8\beta f_S^2} - 1)$

11. $F_S = V_S/\sqrt{gY_S}$

12. $p_1/\rho g + v_1^2/2g = p_2/\rho g + v_2^2/2g + 0.03\ (p_1/\rho g - p_2/\rho g)$

13. $Q = 1.84BH^{3/2}\ [(1+ \alpha\ v^2/2g\ H)^{3/2} - (\alpha\ v^2/2g\ H)^{3/2}]$

14. $k = [(1+ \alpha\ v^2/2g\ H)^{3/2} - (\alpha\ v^2/2g\ H)^{3/2}]$

15. $h = (v^2/2g)(1+ A_1/A_2)^2 = v^2/2g\ (A_1/A_2 - 1)^2$

16. $W = \Sigma_{i=1}\ \frac{p^{2rms(1)} S_i}{\rho C}$, where $\rho C = 420$ RAYLS.

17. $S.I.L = 10 \log_{10} (I) + 120$

18. $L_p = 10 \log (p_1/p_0)^2$ or $(p_1/p_0)^2 = 10^{Lp/10}$

19. $L_p(total) = 10 \log (p_{total}/p_0)^2$

20. $I = W/A$

22. $\eta = \frac{2000 S}{R \rho g}$

23. $\frac{p_1}{\rho g} + \frac{v_1^2}{2g} = \frac{p_2}{\rho g} + \frac{v_2^2}{2g}$

24. $W = \rho g Q h_p$,

25. Turbine output = $\eta_t \rho g Q h_p$,

26. $k=[(1+ \alpha v^2/2g H)^{3/2} - (\alpha v^2/2g H)^{3/2}]$

27. $h= (v^2/2g)(1+ A_1/A_2)^2 = v^2/2g (A_1/A_2 - 1)^2$

28. $Q = a_1 v_1 = a_1 v_2$

29. $h_L = (1/C_c - 1)^2 V_1^2/2g$

30. $A = (b + Ny)y$

31. $P = b + 2y\sqrt{(1+N^2)}$

32. $\Delta Q = \frac{-\Sigma h}{2 \Sigma h/Q}$

33. $SRT = 10 \log_{10} \frac{T_i}{T_t} = 10 \log_{10} \frac{1}{T} = T.L$