SWAZILAND

FACULTY OF HEALTH SCIENCES

DEGREE IN ENVIRONMENTAL HEALTH SCIENCES

(FINAL EXAMINATION)

TITLE OF PAPER : **ACOUSTICS AND HEALTH 1**

COURSE CODE : **EHS 569**

TIME : **3HOURS**

TOTAL MARKS : **100**

INSTRUCTIONS:

- **ANSWER ANY FOUR QUESTIONS**
- **QUESTION 1 (I) IS MULTIPLE CHOICE**
- **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
- **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 Occupational Safety and Health Administration regulations neither require the control of noise exposures, nor employee protection against the effects of noise exposures, and the initiation of comprehensive and effective hearing conservation programs.

b) The effectiveness of a hearing conservation program depends only on the cooperation of employees.

c) The absorption coefficient of any material varies with the angle of incidence of the sound waves.

d) The Occupational Safety and Health Administration regulations neither require the control of noise exposures, nor employee protection against the effects of noise exposures, and the initiation of comprehensive and effective hearing conservation programs.

e) The effectiveness of a hearing conservation program depends only on the cooperation of employees.

f) The absorption coefficient of any material varies with the angle of incidence of the sound waves.

g) For a sinusoidal pressure wave it is found that $P_{rms} = \frac{P_{max}}{\sqrt{2}}$

h) The reverberant field due to the noise radiating directly from the source and the Direct Field due to reflections from the room surfaces.

I) For most noise problems encountered in industry, the sound level meter and octave-band analyzers do not provide ample information.

j) If the wavelength of the sound is small in comparison with the size of an obstacle, the sound is reflected or scattered in many directions.

(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 S.T.P $P = 1.2\ kg/m^2$ and $C = 344\ m/s$.

(5 marks)

QUESTION 2

a) Describe how noise is measured.

(16 marks)

b) What is the frequency of the predominant tone that would be emitted from an axial fan with four blades rotating at 6000 rpm? What are the frequencies of the expected additional tones?

(4 marks)

c) Two sources of different frequency have sound pressure levels of 86 dB and 84 dB. What is the total sound pressure level?

(5 marks)

QUESTION 3

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.

(6 marks)

b) A simple spherical sound source radiates sound into whole space with 5 acoustic watts of power at frequency of 500 Hz. Find the acoustic intensity and sound pressure at radial distances of 1m and 2m from the source.

(14 marks)

c) Four sources are radiating noise in a free field. The sources have the following sound power levels; 120 dB, 123 dB, 90 dB and 92 dB. What is the combined sound power level of these four sources?

(5 marks)

QUESTION 4

a) If a pure tone acoustic wave has a Sound Intensity Level (S.I.L) of 90 dB (re 10^{-12} W/m^2), what is the peak value of the acoustic pressure?

(5 marks)

b) If a pure tone acoustic wave has a S.I.L of 95dB what is the peak value of acoustic pressure?

(8 marks)

c) If an axial flow fan emits 1 watt of acoustic noise, what is its sound power level?

(4 marks)

d) A hydraulic pump driven by a 2kW electric motor has a sound power level of 90dB (re:1 picowatt), what percentage of the electric energy consumed by the pump is emitted as noise?

(8 marks)

QUESTION 5

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

(8 marks)

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

(10 marks]

c) 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?

(7 marks)

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. $W = \sum_{i=1} \frac{p^{2rms(1)} S_i}{\rho C}$, 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. $I = W/A$

21. $L_W = 10 \log W/W_0$

22. $h = \frac{2\sigma \text{Cos } \theta}{R\rho g}$

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