UNIVERSITI SAINS MALAYSIA

1st Semester Examination
2010/2011 Academic Session

November 2010

EAP 583/4 – Air and Noise Pollution Control

Duration : 3 hours

Please check that this examination paper consists of **SEVEN (7)** printed pages including Appendices before you begin the examination.

[Instructions: This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions only.

You must answer the questions in English.

All question **MUST BE** answered on a new sheet.

1. a) Briefly explain the origin of unit decibel (dB) in noise measurement.

[6 marks]

b) Calculate the wavelength of a given sound at following conditions :

Air pressure 101.325 kPa
Air temperature 30ºC
Frequency of sound 10,000 Hz.

[7 marks]

c) Temperature and pressure are the functions of sound intensity. Briefly explain and develop the relationship.

[7 marks]

2. a) With the help of a sketch, define Impulse Noise Type B.

[3 marks]

b) i. Discuss and illustrate the Pure Tone Equation.

[5 marks]

ii. Briefly discuss the effect of distance, wind, temperature and intensity when sound propogates from frequency 10 Hz to 4,000 Hz.

[5 marks]

c) Calculate the value of Leq $_{(1\ jam)}$ from the following monitoring data:

Time (minutes)	Lp, dB (A)
10	84
20	92
30	78
40	83
50	90
60	84
70	77
80	78
90	82
100	90

[7 marks]

3. a) Predict the Leq from following data:

Volume of cars	640 vehicles/hour
Volume of 6 tires truck	120 trucks/hour
Distance to receiver	20 m
Average speed of vehicle	75 km/hour

[4 marks]

b) i. Briefly explain filtering mechanism and bandwidth in noise measurement.

[4 marks]

ii. Differentiate with example 1/1 octave and 1/3 octave filters.

[4 marks]

c) Illustrate different types of sound reflection and solid obstacles.

[4 marks]

d) Briefly discuss main noise control measures at receiver.

[4 marks]

4. Air pollutant emitted from motor vehicles exhaust contributes mainly to air pollution loading in Malaysia. It was estimated that 27 millions vehicles were registered with 80% running on Malaysian road network, whereby half of these are believed to be cars. Calculate annual exhaust emissions loading from cars travelling on Malaysian roads. It was estimated that 5 g/km hydrocarbons and 4 g/km NOx were emitted from a car on a clear day. Suggest emission loading reduction strategies and action to curb the loading from increasing despite the rise in total number of vehicles annually.

[20 marks)]

5. Sulphur dioxide and oxides of nitrogen emissions loads can be reduced by management and engineering control measures. Draw framework to reduce SO_2 and NO_x emissions in urban and industrial areas. Your discussion should include both management and engineering control.

[20 marks]

6. a) Calculate the concentrations of sulphur dioxide at ground level of an open and flat area at points located 3.0km and 5.0km downwind in bright and stable atmospheric condition emitted from a stack of a coal fired power station, with daily mass of solid fuel burned at 3000 tonne. The stack is 40 m height with internal radius of 10 m, exit velocity of 10 m/s at temperature 393 K. Wind velocity at 10 m is 5 m/s. The sulphur content of solid fuel is 2.4%. (in μgm^{-3}). Draw pollution map as a function of distance and concentrations.

[10 marks]

b) Discuss the effects of air pollutants on bricks, mortar, glasses and steels. Give appropriate examples of chemical reactions that should take place.

[10 marks]

7. a) i. Briefly explain why adsorption and absorption are called non-steady state process?.

[2 marks]

ii. Write the similarity and dissimilarity (each one at least **THREE (3)**) between NO_x and SO_x in air pollution control.

[3 marks]

iii. List **FIVE (5)** advantages of the dry-scrubbing process as compared to wet-scrubbing process.

[2 marks]

b) The dust loading of a gas from a cement kiln is 4.1 g/m^3. The design loading before exhaust is 0.065 g/m^3.

i. Calculate the collection efficiency required to obtain the desired exit dust loading if one collector is to be used?

[2 marks]

ii. Calculate the efficiency required if two collectors are used in series (each with the same efficiency)?.

[3 marks]

iii. Calculate the efficiency required for the first collector of two in series, if the efficiency of the second unit is only 75% compared to the first unit?

[5 marks]

c) Cement dust is characterized by very fine Particulate Months. The exhaust gas temperatures from a cement kiln are very hot. Which of the following air pollution control devices would appear to be appropriate?. Explain the reasoning for your selection.

a) Wet scrubber
b) Fabric filters
c) Electrostatic Precipitator
d) Cyclone (Centrifugal) Separators

[3 marks]

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APPENDICE A

Useful formulae:

$C = 20.05T^{1/2}$

$K = C + 273.15$

$I = w/s$

$L_I = 10 \log_{10} I/10^{-12}$

$Lp = 20 \log_{10} (P/Po)$, $Po = 20\ \mu Pa$

Weighted $Lp = 10 \log_{10} (P/Po)$, $Po = 20\ \mu Pa$

$Lw = 10 \log_{10} (w/10^{-12})$

$Leq = 10 \log_{10} \sum ti\ 10^{Li/10}$

$L_{wp} = 10 \log_{10} 1/N \sum 10^{(Lj/10)}$

$L_{pp} = 20 \log_{10} 1/N \sum 10^{(Lj/20)}$

$T_L = 10\log10 \left\{ \frac{s}{\tau 1 s1 + \ldots. + \tau 2 s2} \right\}$

$T_L = 10 \log_{10} 1/\tau$

NNI = Average Peak Noise Level + $15 \log_{10} N - 80$

Average Peak Noise Level = $10 \log10\ 1/N \sum 10^{\text{Peak noise level }/10}$ dB (A)

Traffic $Leq = 42.3 + 10.2 \log (Vc + 6\ Vt) – 13.9 \log D + 0.13\ S$

Traffic $Ldn = 31.0 + 10.2 \log [AADT+ T\%\ AADT/20)] -13.9 \log D + 0.13\ S$

$L_{NP} = Leq + (L_{10}-L_{90})$

$TNI = 4 (L_{10}-L_{50}) + L_{90} -30$

APPENDICE B

σ_z (kelas stabiliti C) = $0.08x\ (1 + 0.0001x)^{-0.5}$

σ_z (kelas stabiliti D) = $0.06x\ (1 + 0.0001x)^{-0.5}$

σ_z (kelas stabiliti F) = $0.04x\ (1 + 0.0001x)^{-0.5}$

σ_y (kelas stabiliti C) = $0.11x\ (1 + 0.0001x)^{-0.5}$

σ_y (kelas stabiliti D) = $0.08x\ (1 + 0.0001x)^{-0.5}$

σ_y (kelas stabiliti F) = $0.16x\ (1 + 0.0003x)^{-1}$

$$q(x,0,0) = \frac{Q}{л\ \bar{u}\ \sigma_z\ \sigma_y} \exp\left[\frac{-\ H^2}{2\ \sigma_z^2}\right]$$

$$q(x,y,0) = \frac{Q}{л\ \bar{u}\ \sigma_z\ \sigma_y} \exp -\left[\frac{y2}{2\ \sigma_y^2} + \frac{H^2}{2\ \sigma_z^2}\right]$$