UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2010/2011

November 2010

IEK 307 – NOISE AND VIBRATION CONTROL TECHNOLOGY
[TEKNOLOGI KAWALAN HINGAR DAN GETARAN]

Duration: 3 hours
[Masa: 3 jam]

Please check that this examination paper consists of <u>EIGHT</u> pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi <u>LAPAN</u> muka surat bercetak sebelum anda memulakan peperiksaan ini.]

Instructions: Answer <u>FIVE</u> questions. All questions can be answered either in Bahasa Malaysia or English.

*[<u>**Arahan:**</u> Jawab <u>LIMA</u> soalan. Semua soalan boleh dijawab sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggah pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

1. (a) Calculate sound pressure level and sound power level for the following:-

    (i) 2×10^5 Pa
    (ii) 0.106 Pa
    (iii) 5×10^{-3} Pa
    (iv) 600 W
    (v)   0.06 W

    [10 marks]

    (b) The noise level of a small sewing machine is 85 dB. When it runs together with an adjacent larger machine, the combined level is measured as 95dB. What is the noise level for the larger machine?

    [10 marks]

2. (a) Prove that:-
    $$L_p = 20 \, Log_{10}(P) + 94 \quad [dB]$$

    [10 marks]

    (b) Sound pressure level at the point r=5m from noise source is 75 dB. Calculate the sound pressure level at the point 15m from the point source:-

    (i)   if the noise source is a point source
    (ii) if the noise source is a line source.

    [10 marks]

3. (a) Estimate the sound attenuation at the point 15m from a perfect barrier whose height is 2.5m and located 5m from a blower pump.

    Table 1

f(Hz)	63	125	250	500	1000	2000	4000
(m)							
N							
A_b (dB)							

    [15 marks]

(b) Calculate the noise attenuation caused by grass or tree at the buffer zone along highway at a frequency of 125 and 1000 Hz.

   (i) A grove of tree 200 m deep
   (ii) a dense cornfield 150 m deep

[5 marks]

4. (a) A wall with a transmission loss of 40 dB at 500 Hz separates two packaging areas. A window with a transmission loss of 20 dB at 500 Hz is to be installed which will occupy 15% of the wall. Calculate the resultant composite transmission loss of the wall at 500 Hz.
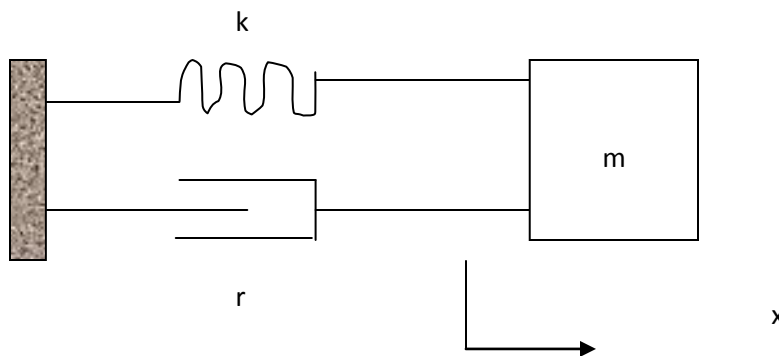
[10 marks]

(b) Explain the following keywords:-

   (i) Noise reduction, NR
   (ii) Insertion loss, IL

[10 marks]

5. Refer to the following figure,

(a) Derive the governing equation for the above system.
(b) Derive the general solution for the system.

[12 marks]

(c) If mass is 10 kg, spring constant k= 1000 N/m and viscous damping coefficient, r is 10 N-s/m, what are the critical damping ratio and the damped natural frequency of the system?

[8 marks]

6. (a) Table below shows an instantaneous spectral analysis for landing approach of a jet aircraft. This analysis was obtained using one octave band spectrum.

Table 2

Center Frequency (Hz)	Sound Pressure Level (dB)
63	70
125	73
250	75
500	80
1000	88
2000	86
4000	80
8000	79

Calculate:-

(i)   The perceived noise level
(ii) The perceived noise

[10 marks]

(b) Equivalent sound levels were measured continuously for a 24 hours period near a highway. The levels for the daytime, evening and nighttime periods were, respectively, 72, 68 and 65 dBA. Calculate the community noise equivalent level CNEL for the 24 hours period.

[10 marks]

1.   (a)   Kirakan tahap tekanan bunyi dan tahap kuasa bunyi bagi:-

(i) $2 \times 10^5 Pa$
(ii)   0.106 Pa
(iii) 5×10^{-3} Pa
(iv)   600 W
(v)   0.06 W

[10 markah]

(b)   Tahap hingar sebuah mesin jahit kecil ialah 85 dB. Tahap gabungan hingar diukur pada 95 dB bila ia beroperasi dengan sebuah mesin jahit besar berdekatan. Apakah tahap hingar bagi mesin jahit besar?

[10 markah]

2.   (a)   Buktikan bahawa:-

$$L_p = 20\ Log_{10}(P) + 94 \quad [dB]$$

[10 markah]

(b)   Tahap tekanan bunyi di titik r=5m dari punca hingar ialah 75 dB. Kirakan tahap tekanan bunyi di kawasan berjarak 15m dari punca hingar:-

(i)   Sekiranya punca hingar adalah punca titik
(ii)   Sekiranya punca hingar adalah punca garisan.

[10 markah]

3.   (a)   Menggunakan jadual di bawah, anggarkan penurunan hingar di kedudukan 15m dari satu tembok yang bersifat sempurna setinggi 2.5 m yang terletak 5m dari satu pam peniup.

Jadual 1

f(Hz)	63	125	250	500	1000	2000	4000
(m)							
N							
A_b (dB)							

[15 markah]

(b) Hitungkan penurunan hingar yang disebabkan oleh rumput atau pokok di kawasan penampan di sepanjang lebuh raya pada frekuensi 125, 1000 Hz.

  (i) Sekelompok pokok setebal 200 m
  (ii) Ladang jagung setebal 150 m

[5 markah]

4. (a) Satu tembok yang menyebabkan kehilangan transmisi 40 dB pada frekuensi 500 Hz memisahkan dua tempat pembungkusan. Satu tingkap yang menyebabkan kehilangan transmisi 20 dB pada frekuensi 500 Hz akan dipasang. Hitungkan kehilangan transmisi gabungan pada frekuensi 500 Hz yang terhasil sekiranya luas tingkap adalah 15% daripada keluasan tembok.
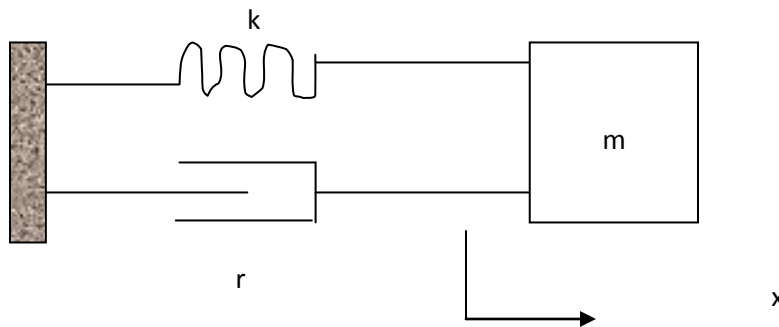
[10 markah]

(b) Jelaskan istilah-istilah berikut:-

  (i) Penurunan hingar, NR
  (ii) Kehilangan sisipan, IL

[10 markah]

5. Merujuk kepada gambarajah di bawah,

(a) Terbitkan persamaan menakluk bagi sistem di atas.
(b) Tunjukkan penyelesaian umum bagi sistem tersebut.

[12 markah]

(c) Sekiranya berat jisim ialah 10 kg, pemalar spring k= 1000 N/m dan pekali redaman likat, r = 10 N-s/m, apakah nisbah redaman kritikal dan frekuensi terendam tabii bagi sistem tersebut?

[8 markah]

6. (a) *Jadual di bawah menunjukkan analisa spektra segera bagi percubaan pendaratan sebuah kapalterbang jet. Analisis ini di buat menggunakan 'one octave band' spektrum.*

Jadual 2

Frekuensi Tengah (Hz)	Tahap Tekanan Bunyi (dB)
63	70
125	73
250	75
500	80
1000	88
2000	86
4000	80
8000	79

Hitungkan:-

(i) *Tahap hingar dipercayai*

(ii) *hingar dipercayai*

[10 markah]

(b) *Tahap bunyi setara diukur secara berterusan selama 24 jam berhampiran lebuhraya. Tahap bagi waktu siang, petang dan malam adalah masing-masing 72,68,65 dBA. Hitungkan tahap hingar setara komuniti CNEL untuk waktu 24 jam.*

[10 markah]

Summary of formulas

$$L_p = 10 \log_{10}\left(\frac{P^2}{P_0^2}\right)$$

$$L_w = 10 \log_{10}\left(\frac{w^2}{w_0^2}\right)$$

$$L_{p,avg} = 10 \log_{10}\left(\sum_{i=1}^{n} 10^{\frac{L_{p,i}}{10}}\right)$$

$$L_p = L_w + DI_\theta - 20 \log_{10}(r) - 11 [dB]$$

$$L_{p,r2} = L_{p,r1} - 10 \log_{10}\left(\frac{r2}{r1}\right)[dB]$$

$$A_t = f^{1/3}\left[\frac{dB}{100m}\right]$$

$$A_g = 18 \log_{10}(f) - 31\left[\frac{dB}{100m}\right]$$

$$f = kx, \quad f = ma, \quad f = r\frac{dx}{dt}$$

$$TL_c = 10 \log_{10}\left(\frac{1}{\bar{\tau}}\right), \quad \bar{\tau} = \frac{1}{S}\sum_{i=1}^{n}\tau_i S_i$$

$$A_b = 20 Log_{10}\left(\frac{\sqrt{2\pi N}}{\tanh\sqrt{2\pi N}}\right) + 5 \quad [dB]$$

$P_0 = 2.0 \times 10^{-5}$ Pa

$W0 = 1.0 \times 10^{-12}$ W

$$PN = N_m\left(1 - K\right) + K\sum_{i=1}^{n} N_i$$

$$L_{PN} = 40 + 33.3 Log_{10}\left(PN\right)$$

$$CNEL = 10 Log_{10}\left[\frac{1}{24}\left(12 \times 10^{L_D/10} + 3 \times 10^{(L_e+5)/10} + 9 \times 10^{(L_n+10)/10}\right)\right]$$

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