UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2010/2011

COURSE NAME	:	NOISE AND VIBRATION
COURSE CODE	:	BDC 4013
PROGRAMME	:	4 BDD
EXAMINATION DATE	:	NOVEMBER/DECEMBER 2010
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER **FOUR** (4) QUESTIONS ONLY

THIS PAPER CONTAINS TEN (10) PAGES INCLUDING COVER PAGE

Q1 **Figure Q1** shows a rigid body system which consists of several trolleys attached with each other by the elastic rod. The system has the function to receive and discharge tools from the trolleys attached with each other alternately once the external force F applied on it at the production line. The rod has three segments and each rod is denoted as k_1, k_2 and k_3 respectively. Given that $m_1 = m_2 = \text{m}$, $m_3 = 2\text{m}$, while $k_1 = k_2 = \text{k}$, $k_3 = 2\text{k}$.

(a) Find the stiffness influence coefficients of the system.

[5 marks]

(b) Calculate the flexibility influence coefficient of the system.

[4 marks]

(c) Determine the natural frequencies (eigenvalues) of the system.

[8 marks]

(d) Calculate the mode shapes (eigenvectors) of the system.

[8 marks]

Q2 A three coaches train system shown in **Figure Q2 (a)** can be simplified as a three degree of freedoms semi definite mass-spring system as illustrated in **Figure Q2 (b)**. The masses of the three coaches are m_1 = 15000 kg, m_2 = 10000 kg and m_3 = 15000 kg. The three masses are connected in series by two springs having stiffness constant of $k_1 = k_2$ = 10000 N/mm. The friction between the coaches' wheels and the rail can be neglected.

(a) Derive the equations of motion for the train system and determine the appropriate expressions to find the natural frequencies and mode shapes of the system by mean of Holzer's method.

[8 marks]

(b) Using Holzer's method determine the natural frequencies and the mode shapes of the train system. Use frequency searching incremental, $\Delta\omega$ =10 rad/s, starting from 0.

[14 marks]

(c) Draw the mode shape diagram for each of the corresponding mode.

[3 marks]

Q3 (a) Describe the following hand-arm transmitted vibration:

(i) vascular disorders

(ii) Neurological disorders

(iii) Carpal-tunnel syndrome

(iv) Musculoskeletal disorders

[8 marks]

(b) A carpenter uses three tools during a working day: An angle grinder: 4 m/s^2 for 3 hours, An angle cutter: 3 m/s^2 for 3.5 hours and A chipping hammer: 20 m/s^2 for 1.5 hours.

(i) Calculate the partial vibration exposure for each tool.

(ii) Calculate the daily vibration exposure.

[8 marks]

(c) (i) Explain briefly the Exposure Action Limit (EAL) and Exposure Limit Value (ELV).

(ii) The Vibration Directive sets an exposure action value for daily vibration exposure, above which it requires employers to control the hand-arm vibration risks of their workforce and an exposure limit value above which workers must not be exposed:

- a daily exposure action value of 2.5 m/s^2.
- a daily exposure limit value of 5 m/s^2.

Using the Hand-arm vibration Nomogram, **Figure Q3 (a)** and Daily Exposure Graph, **Figure Q3 (b)**, determine the Exposure Action Limit (EAV) and Exposure Limit Value (ELV) of each tool in Q3 (b).

[9 marks]

Q4 (a) Explain the following relating to noise:

(i) Temporary Threshold Shift (TTS)

(ii) Noise Induced Hearing Loss (NIHL)

(iii) Hearing Conservation Programme

[6 marks]

(b) Describe the two types of silencers and sound attenuators.

[4 marks]

(c) Measurements were undertaken for a generator set inside a laboratory in octave band centre frequency with sound level meter set to 'Linear' weighting as shown below. The required noise levels criterion is NR 80 (**Figure Q4**). Two types of silencers were selected to be used with the generator set, that are NAP D47/120 and SAL RAS/MD-90 with insertion loss shown in the **Table Q4**. Determine for each silencer:

(i) The predicted nett sound pressure level in Db(A).

(ii) The overall sound pressure level with silencer in Db(A).

[15 marks]

Table Q4

Frequency (Hz)	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***
Measured Sound Pressure Level Db	94	97	100	100	97	96	90
Insertion Loss							
NAP D47/120	4	8	17	27	30	21	14
SAL RAS/MD-90	6	7	14	20	24	18	14

Q5 (a) (i) Define the room constant, R and the reverberation time, RT.

(ii) Given that:

$$\text{Room constant, } R = \frac{S\bar{\alpha}}{1-\bar{\alpha}}$$

$$\text{Reverberation time, } RT = \frac{0.16V}{S\bar{\alpha}}$$

Explain the term S, V and $\bar{\alpha}$ use in above equations.

[10 marks]

(b) A new factory space was measured as 42 m length, 25 m width and 10 m high. Floor surfaces are concrete, while walls and roof are of sheet metal decking. Estimate the room constant, R and reverberation time, RT of this factory space. (Use **Table Q5 (a)** in the calculation).

[8 marks]

Table Q5 (a)

Room or Space Acoustic Environment	Typical Range of $\bar{\alpha}$
Live	0.07
Fairly Live	0.15
Average	0.40
Fairly Dead	0.50

(c) A noise control enclosure is to be used in turn for two sources X and Y. Determine the 'A' weighted attenuation for each source and discuss these results. **Table Q5 (b)** below gives the specifications.

[7 marks]

Table Q5 (b)

Frequency Hz	63	125	250	500	1000	2000	4000	8000
Source X dB(A)	90	80	70	60	50	40	30	20
Source Y dB(A)	20	30	40	50	60	70	80	90
Barrier Performance dB	15	17	20	23	26	29	32	35

Q6 (a) Explain the effect of noise on human when the human is undergoing prolong and continuous exposure?

[6 marks]

(b) Hearing range can be divided into three main ranges called infrasound, audible sound and ultrasound. Define each range by relate them with human, animal, tool and machinery.

[6 marks]

(c) A new room plan to be built besides existing production line in a factory. The room has the dimension of 50 x 30 x 10m. The room utilize sheet metal roof and wall with the value of $\alpha = 0.1$. The new exhaust fan with the Sound Power Level (SWL) of 98dBA also equipped at the end corner with the nearest workers 5m away. The existing noise level is 88 dBA. Calculate the noise level at workers position with new fan operations.

[13 marks]

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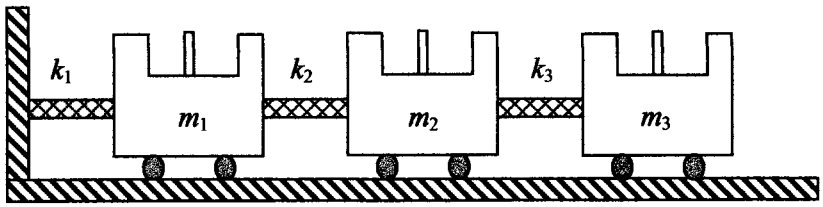

Figure Q1

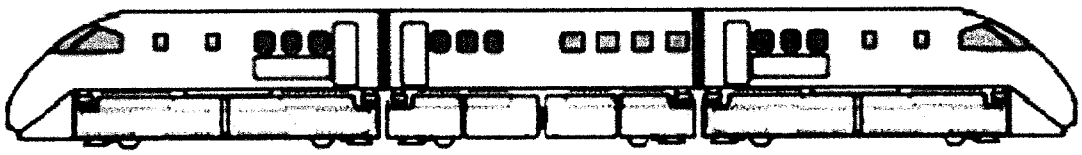

Figure Q2 (a)

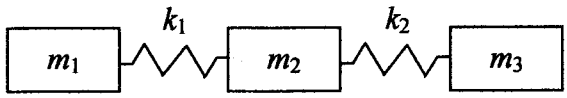

Figure Q2 (b)

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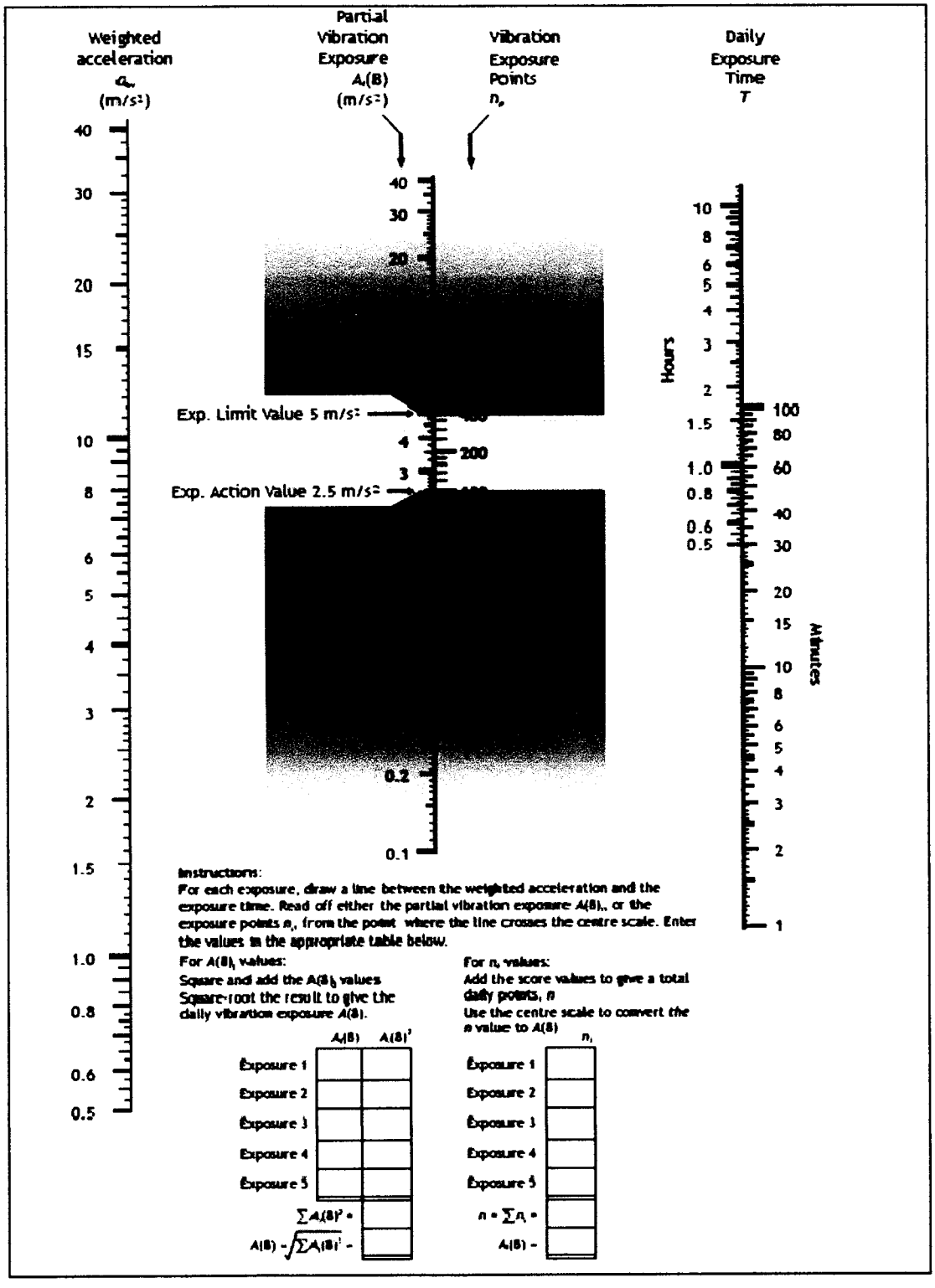

Figure Q3 (a)

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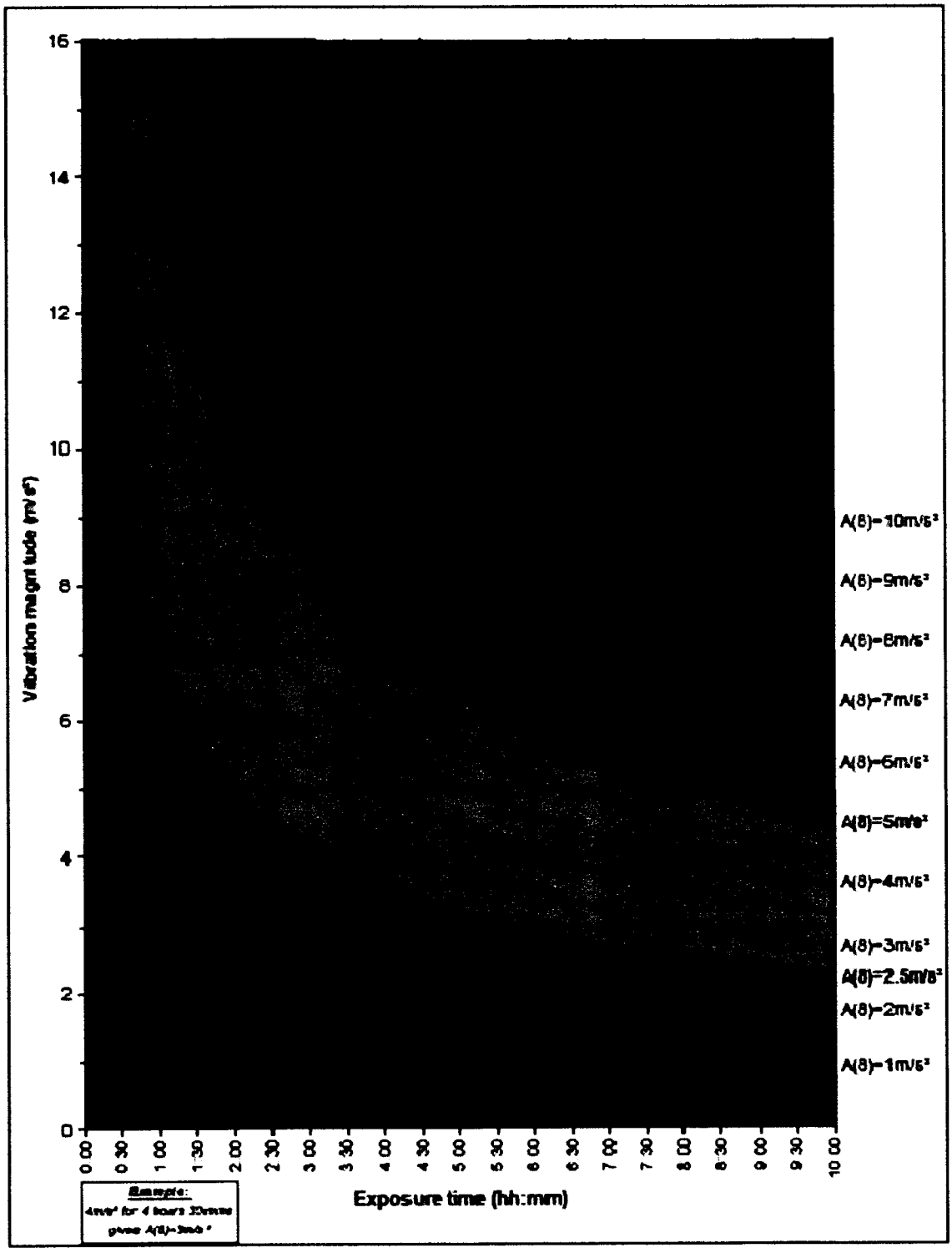

Figure Q3 (b)

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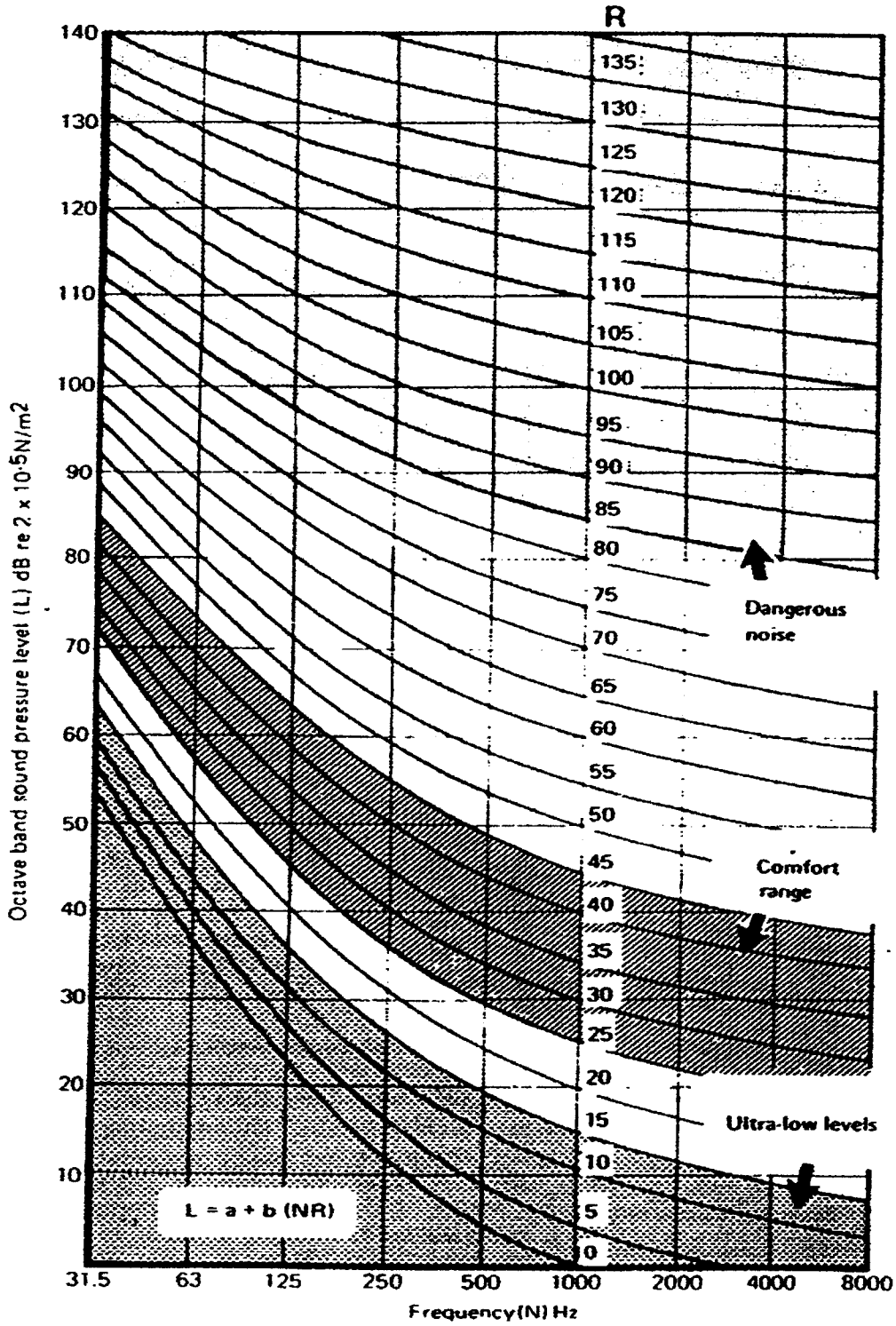

Figure Q4