UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2009/2010

SUBJECT	:	NOISE AND VIBRATION
SUBJECT CODE	:	BDC 4013
COURSE	:	4BDD/BDI
EXAMINATION DATE	:	APRIL/MEI 2010
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER FOUR (4) OUT OF SIX (6) QUESTIONS

THIS PAPER CONSIST OF EIGHT (8) PAGES

Q1 (a) Describe briefly all factors that affect sound insulation.

(5 Marks)

(b) Explain the Noise Reduction Coefficient, NRC.

(3 Marks)

(c) A wall 6 m length and 3.5 m high shall be built using the hollow concrete blocks, as a wall separation between an operator's room and the remaining areas of a noisy factory. There is also a door (2.1 m high x 1 m width), and a glass window (1.2 m width x 1.2 m high) on this wall. The transmission loss data of these materials are as tabulated in **Table 1**. Calculate the composite transmission loss of the wall separation at 500 Hz and 2000 Hz. (Use Nomogram in **Figure Q1** for Overall Transmission Loss Determination). Comment on the results obtained.

(9 Marks)

(d) If the sound pressure level outside the operator's room in (c) are as given in the tabulated in **Table 1**, estimate the sound pressure levels inside the operator's room at 500 Hz and 2000 Hz. Comment on the results obtained. The operator's room dimensions are 6 m length x 3.5 m width x 3.5 m high. The sound absorption coefficients inside the operator's room are shown below.

(8 Marks)

Frequency (Hz)	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**
Transmission Loss TL							
Hollow Concrete	22	27	32	32	40	41	45
Timber Door	13	17	21	26	29	31	34
Glass	25	23	31	38	40	47	52
Absorption Coefficients							
Average for room	0.15	0.15	0.1	0.1	0.2	0.25	0.25
Sound Pressure Level							
Outside Room, dBA	80	85	92	95	95	90	92

Table 1

Q2 (a) The one hour $L_{eq\ 1hr}$ at a work station in a factory was measured over an 8 hour working day as in **Table 2**:

Hour	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
$L_{eq\ 1hr}$ dBA	88	95	89	95	78	95	87	98

Table 2

Compute the equivalent continuous sound pressure level over an 8 hour working day (L_{eq8hr}). Make an assessment of the noise exposure for a worker at this workplace in context to the Malaysian Noise Exposure Regulations 1989.

(5 Marks)

(b) The Sound pressure level (L_w) inside an enclosure at various frequencies are as given in **Table 3**. The internal surface area inside enclosure, S is 78 m^2. If the internal conditions inside the enclosure are fairly dead with correction factorsC_1 as shown, determine:

(i) The sound pressure level (L_p) inside the enclosure at each frequency.
(ii) The overall sound pressure level.

(10 marks)

Frequency (Hz)	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**
L_w	92	98	94	91	88	83	80
Internal Area							
78m^2	19	19	19	19	19	19	19
Fairly dead C_1	11	9	6	5	3	2	1

Table 3

(c) The sound pressure levels measured at the receiver without barrier in a factory are as shown in **Table 4**. Two barriers were proposed to be used at the path to reduce the sound pressure level at the receiver which has the sound reduction as given. Determine,

(i) the resultant sound pressure level at each frequency.
(ii) the effective attenuation at each frequency.

(10 marks)

Frequency (Hz)	125	250	500	1k	2k	4k
SPL without barrier	100	100	100	100	100	100
Reduction path 1	15	17	20	23	26	29
Reduction path 2	18	21	24	27	30	33

Table 4

Q3 A room is illustrated in **Figure Q3**, the surface definition and the corresponding materials for every surface are explained in the figure.

The absorption coefficient data of the materials are as in **Table 5**:

	Absorption coefficient at certain frequency					
Material	**125 Hz**	**250 Hz**	**500 Hz**	**1000 Hz**	**2000 Hz**	**4000 Hz**
Material 1	0.02	0.03	0.04	0.04	0.04	0.05
Material 2	0.01	0.02	0.02	0.02	0.02	0.02
Material 3	0.04	0.05	0.05	0.04	0.04	0.03
Material 4	0.01	0.01	0.02	0.02	0.02	0.01

Table 5

(a) Determine the Noise Reduction Coefficient (NRC) which is the representative of absorption coefficient (α) of each material.

(3 Marks)

(b) Calculate the room average sound absorption coefficient $\bar{\alpha}$ by considering all surfaces and the materials.

(4 Marks)

(c) Predict the Reverberation Time of the room, and explain briefly the result related to the definition of the Reverberation time.

(6 Marks)

(d) Calculate the Sabine's Room Constant, R.

(6 Marks)

(e) If there is a sound source next to the side wall 1 with the level of 80 db(A) and the design of the transmission loss of the room is 30dB(A), predict the level of noise that will be received inside the room.

(6 Marks)

Q4 Noise measurement investigation has been conducted in a class room to assess whether the noise level is acceptable for a class room. The mapping measurement data is shown in **Figure Q4**.

(a) What is the equipment to measure to noise level in this room and what is the transducer sensor to record the noise.

(2 Marks)

(b) If you want to investigate the characteristics of the noise in terms of the frequency contents at one of the point of measurements, explain how you can get the frequency contents.

(6 Marks)

(c) What is the representative average noise level of this room?

(10 Marks)

(d) In a factory manufacturing workshop, the level of noise is recorded as high as 95 db(A) constantly during the working hours. Calculate the NIOSH maximum time of exposure at this noise level.

(10 Marks)

Q5 A spring-mass-damper system is subjected to a harmonic motion $y(t)$ as shown in **Figure Q5**, where x and y denote, the absolute displacements of the mass m and the end Q of the dashpot c_1 respectively.

(a) Draw the free body diagram for the system. (4 Marks)

(b) Derive the equation of motion of the mass m. (7 Marks)

(c) Find the steady state displacement of the mass m. (7 Marks)

(d) Find the force transmitted to the support at P. (7 Marks)

Q6 An automobile is travelling over a rough road. One of the wheels and leaf springs of the automobile is shown in **Figure Q6**. For simplicity, all the wheels can be assumed to be identical. The automobile has a mass of $m_1 = 1000$ kg and the leaf springs have a total stiffness of $k_1 = 400$ kN/m. The wheels and the axle have a mass of $m_2 = 300$ kg and the tires have a stiffness of $k_2 = 500$ kN/m. If the road surface varies sinusoidally with a period of $\lambda - 6$ m, find the critical velocities, v_i of the automobile, where $v_i = f_i\lambda$ $(i = 1, 2)$.

(25 Marks)

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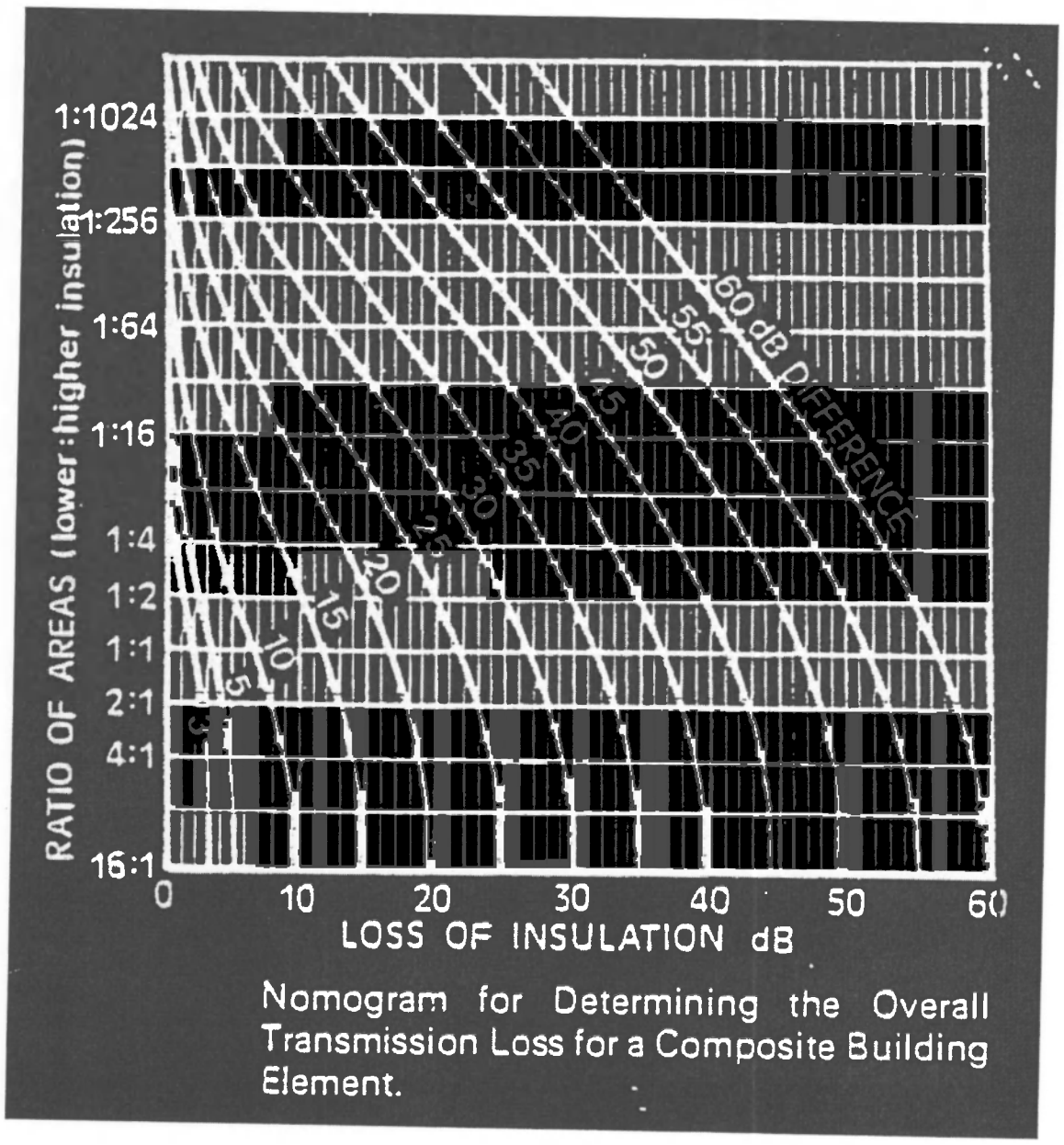

Figure O1

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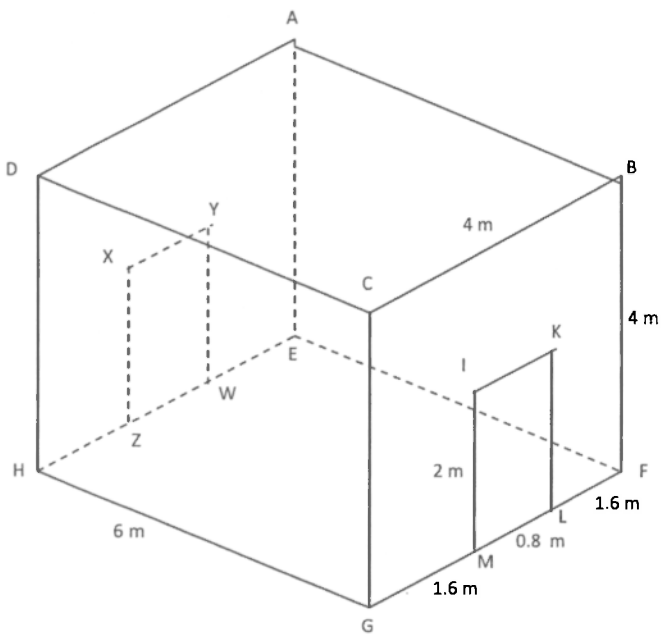

EFGH: Floor, material 4

ABCD : Ceiling, material 1

CBFLKIMG: Front wall, material 2

IKLM: Front door, material 3

DCGH: Side wall 1, material 2

ABFE: Side wall 2, material 2

DAEWYXZH: Back wall, material 2

XYWZ: Back door, material 3

Figure Q3

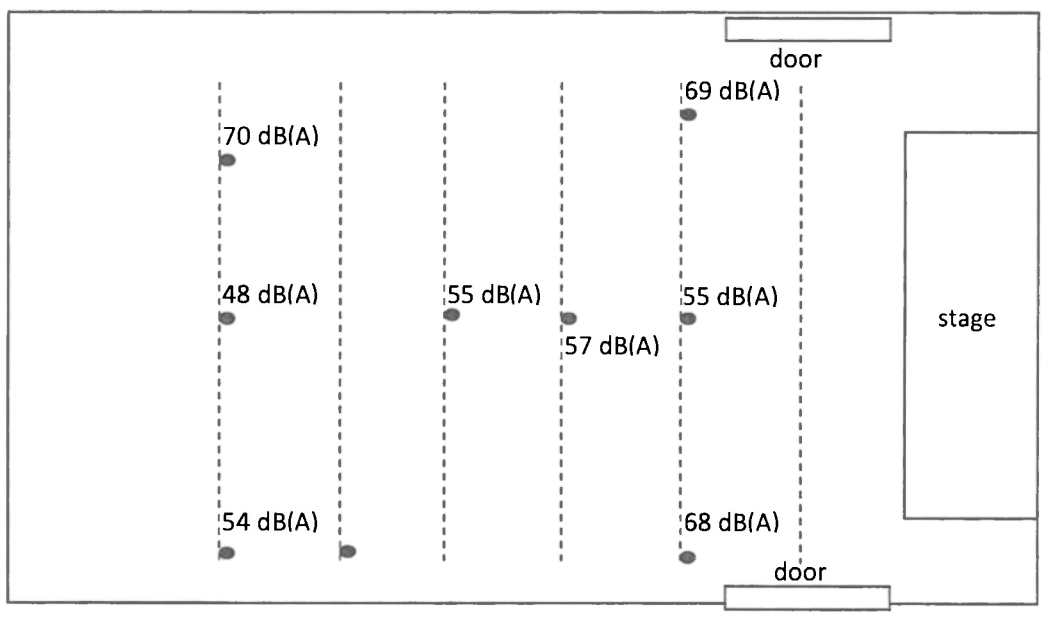

Figure Q4

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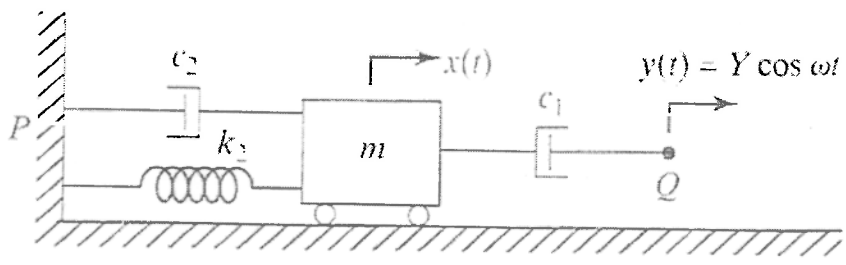

Figure Q5

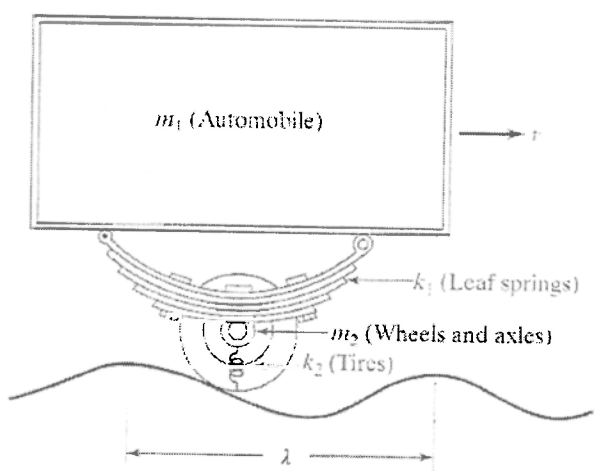

Figure Q6