UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	NOISE AND VIBRATION
COURSE CODE	:	BDC 4013
PROGRAMME	:	BACHELOR OF MECHANICAL ENGINEERING
EXAMINATION DATE	:	JUNE 2012
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	ANSWER **FOUR** (4) QUESTIONS OUT OF **FIVE (5)** QUESTIONS.

THIS PAPER CONSIST OF EIGHT (8) PAGES

Q1 (a) Explain briefly the basic concept use in vibration in terms of lumped parameter systems and distributed systems.

(2 marks)

(b) A two degree of freedom system which consists of mass m_1 and m_2 are displaced with small linear displacement x_1 and small angle of oscillation θ as shown in **Figure Q1(b)**. The linear displacement, $x_2 = x_1 + L \sin\theta$ where L is the length of the pendulum.

(i) Determine the first equation of motion of this system.

(5 marks)

(ii) Determine the second equation of motion by considering the moments about point O.

(5 marks)

(iii) Assume that $x = X \sin \omega t$ and $\theta = \Theta \sin \omega t$, Show that the frequency equation of the system is

$$\begin{bmatrix} 2k + (m_1 + m_2)\omega^2 & -m_2 L\omega^2 \\ -m_2 L\omega^2 & m_2 gL - m_2 L^2\omega^2 \end{bmatrix} = 0$$

(5 marks)

(c) A horizontal force, F sin ωt is applied to the mass m_1 of the system shown in **Figure Q1(b)** and assume $x = X \sin \omega t$ and $\theta = \Theta \sin \omega t$. If m_1 is stationary, determine the frequency, ω of this system. Take g = 9.81 m/s^2 and L = 1.5 m.

(8 marks)

Q2 (a) What is the Rayleigh's quotient of the discreet or lumped parameter system?

(3 marks)

(b) The shaft shown in **Figure Q2(b)** carrying three masses as shown with m_1 = 30 kg, m_2 = 60 kg and m_3 = 50 kg. The distance between the masses are l_1 =1.5 m, l_2 = 3.0 m, l_3 = 5.0 m and l_4 = 2.5 m. The shaft is made of steel with a solid circular cross section of diameter 150 mm and modulus of elasticity, E = 2.07 x 10^{11} N/m^2.

(i) Show that the deflection $w(x)$ of the shaft due to a static load P as in **Figure Q2(b)(i)** is given by

$$w(x) = \begin{cases} \dfrac{Pbx}{6EIl}(l^2 - b^2 - x^2); & 0 \le x \le a \\ -\dfrac{Pa(l-x)}{6EIl}(a^2 + x^2 - 2lx) & a \le x \le l \end{cases}$$

(6 marks)

(ii) Determine the deflection due to m_1 at the location of m_1, m_2 and m_3.
(4 marks)

(iii) Determine the deflection due to m_2 at the location of m_1, m_2 and m_3.
(4 marks)

(iv) Determine the deflection due to m_3 at the location of m_1, m_2 and m_3.
(4 marks)

(v) Estimate the fundamental frequency, ω of the lateral vibration of the shaft.
(4 marks)

Q3 (a) What is single – plane balancing?
(3 marks)

(b) The data obtained in a two-plane balancing procedure of a turbine rotor are given in the table below. The data were obtained from measurement of the original unbalance, the right-plane trial weight and the left-plane trial weight. Assuming that all angles are measured from an arbitrary phase mark and all weights are added at the same radius. Determine

(i) the vibration amplitude and phase of original unbalance at A and B.
(4 marks)

(ii) the effect of unbalance in left plane, L due to vibration at bearing A and B, A_{AL} and A_{BL}.
(4 marks)

(iii) the effect of unbalance in right plane, R due to vibration at bearing A and B, A_{AR} and A_{BR}.
(4 marks)

(iv) the unbalance vectors, U_L and U_R.
(4 marks)

(v) the magnitude and angular position of the balancing masses.
(4 marks)

	Amplitude		Phase Angle	
Condition	Bearing A	Bearing B	Bearing A	Bearing B
Original unbalance	5	4	100°	180°
M_L = 2 kg added at 30° in the left plane	6.5	4.5	120°	140°
M_R = 2 kg added at 0° in the right plane.	6	7	90°	60°

(c) If the balance weights on the turbine rotor in (b) are added at different radius, what will happen to the turbine rotor. Give your comment.

(2 marks)

Q4 (a) Describe briefly what is the sound absorption and sound insulation of a material.

(5 marks)

(b) A room 10 meter x 8 meter x 3 meter height was built as follows;
The walls were built with painted brickwork. The door of area, 8 m^2 was from plywood with air space behind. The windows area 10 m^2 was from 4 mm glass pane. Rubber floor tiles was used for the floor and the 25 mm rockwool blanket was attached to the ceiling. The absorption coefficient at octave band centre frequency of these materials are as shown in **Table Q4(b)**. Determine the Noise Reduction Coefficient (NCR), α of each material and calculate;

(i) the average sound absorption coefficient, α_{mean}.

(5 marks)

(ii) the room constant, R_C.

(5 marks)

(iii) the reverberation time, RT.

(5 marks)

(c) From the value calculated in Q4(b)(i) and referring to **Table Q4(c)**, give your comment on the acoustic environment of the room.

(5 marks)

Q5 (a) A supervisor in a factory has been exposed to the following noise levels and duration.

dB(A)	Time (hour)
94	3
89	2
98	0.5
83	2.5
95	1.5
85	0.5

Calculate;

(i) the average sound pressure, L_{AV} that he received.

(3 marks)

(ii) the equivalent continuous noise level in 8 hours.

(3 marks)

(iii) the equivalent continuous noise level in 12 hours.

(3 marks)

(b) Give your comments on the values calculated in (a)(i), (ii) and (iii).

(2 marks)

(c) The approximation sound pressure level inside the enclosure is given as below;

$$L_p = L_w - 10 \log S + C_l + 6$$

Where,

L_p = Sound Pressure Level inside enclosure.
L_w = Sound Power Level of source.
S = Internal surface area inside enclosure.
C_l = Correction factor for acoustic environment Inside enclosure.

The Sound Power Level, L_w of a source in an enclosure was measured with octave band as shown. The internal area inside the enclosure is 78 m^2. If the acoustic environment inside enclosure is to be fairly live (refer to **Table Q5(c)**), calculate;

(i) Sound Pressure Level, L_p inside enclosure at each octave band.

(4 marks)

(ii) the overall Sound Pressure Level, L_p.

(3 marks)

Frequency, Hz	63	125	250	500	1k	2k	4k
L_w	92	98	94	91	88	83	80

(d) Explain briefly on the Dissipative and Reactive types of silencers.

(7 marks)

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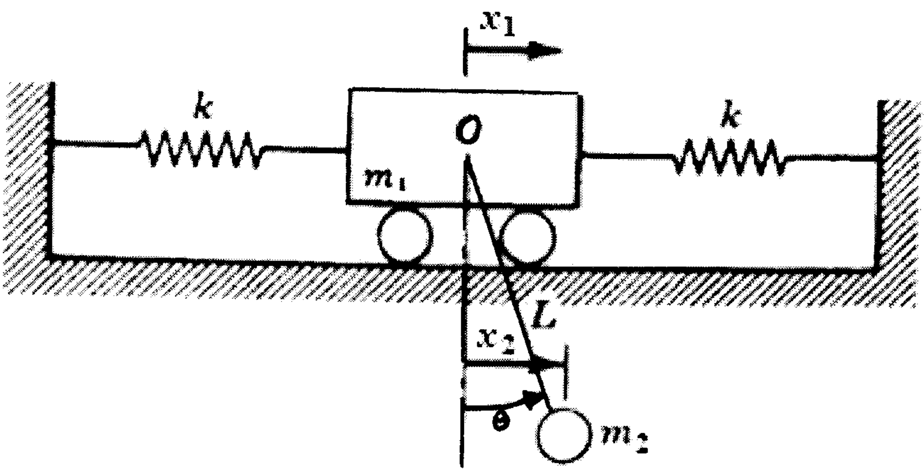

Figure Q1(b)

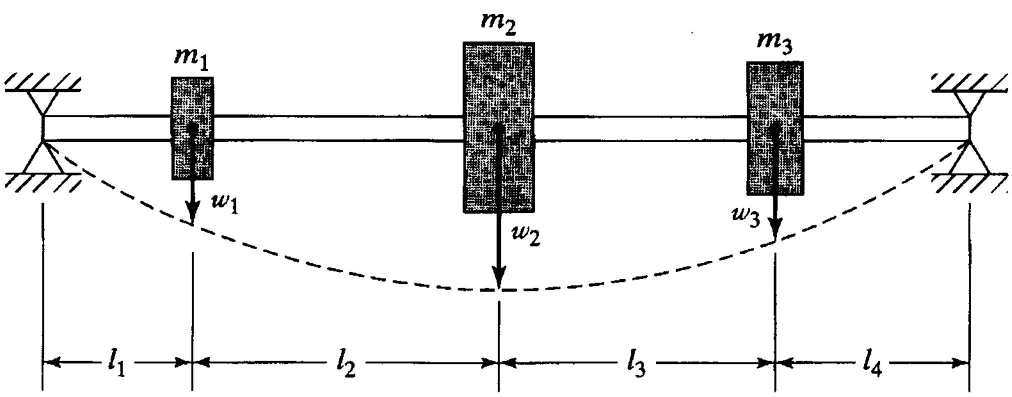

Figure Q2(b)

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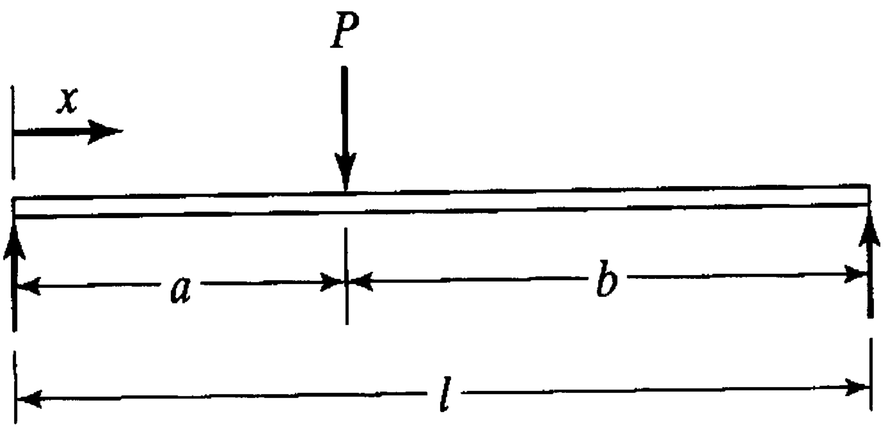

Figure Q2(b)(i)

Materials	Absorption coefficient at octave band centre frequencies (Hz) 63	125	250	500	1000	2000	4000	NRC (α)
Painted brickwork	0.01	0.01	0.015	0.02	0.02	0.025	0.03	α_1
Plywood with airspace behind	0.25	0.32	0.43	0.12	0.07	0.07	0.11	α_2
4 mm glass pane	0.25	0.35	0.25	0.18	0.12	0.07	0.04	α_3
Rubber floor tiles	0.05	0.05	0.05	0.1	0.1	0.05	0.05	α_4
25 mm rockwool blanket	0.05	0.1	0.35	0.6	0.7	0.75	0.8	α_5

Table Q4(b)

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Room or Space Acoustic Environment	Typical range of α_{mean}
Live	0.02-0.07
Fairly Live	0.07 - 0.15
Average	0.15 - 0.40
Fairly Dead	0.40 - 0.50
Dead	0.50 - 0.80

Table Q4(c)

Correction C1							
Interna Conditions	63	125	250	500	1k	2k	4k
Live	18	16	15	14	12	13	15
Fairly Live	16	13	11	9	7	6	6
Average	13	11	9	7	5	4	3
Fairly Dead	11	9	6	5	3	2	1
Dead	9	6	4	2	0	-1	-1

Table Q5(c)