SULIT

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2011/2012

COURSE NAME	:	VIBRATION & NOISE
COURSE CODE	:	BDC 4013
PROGRAMME	:	4 BDD
EXAMINATION DATE	:	JANUARY 2012
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER **TWO (2)** QUESTIONS FROM **PART A** AND **TWO (2)** QUESTIONS FROM **PART B**

THIS PAPER CONTAINS EIGHT (8) PAGES INCLUDING COVER PAGE

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PART A

Q1 A machine tool, having a mass of m = 1,000 kg and a mass moment of inertia of J_0 = 300kg-m^2, is supported on elastic supports, as shown on **Figure Q1**. If the stiffness of the supports are given by k_1 = 3,000 N/mm and k_2 = 2,000 N/mm, and the supports are located at l_1= 0.5 m and l_2 = 0.8 m.

(a) Draw the free body diagram of the system.

[4 marks]

(b) Determine the equation of motion in term of x and θ.

[6 marks]

(c) Calculate the natural frequencies and mode shapes of the machine tool.

[15 marks]

Q2 (a) Name the five methods available for vibration control.

[5 marks]

(b) Differentiate between the active and passive vibration control.

[2 marks]

(c) A fragile instrument weighing 200 N is suspended by four identical springs, each with stiffness 50 kN/m, in a rigid box as shown in **Figure Q2**. The box is transported by a truck that subjected to a vertical harmonic motion given by $y(t)$ = 0.002 sin 10t.

(i) Find the maximum displacement, velocity and acceleration experienced by the instrument.

[8 marks]

(ii) What will happen to the movement of the instrument when increasing the spring with any similar value of stiffness. Prove with calculation.

[10 marks]

Q3 A rotor, having a mass moment of inertia $J_1 = 15$ kgm^2 is mounted at the end of a steel shaft having a torsional stiffness of 0.6 MNm/rad. The rotor is found to vibrate violently when subjected to a harmonic torque 300 cos 200t Nm. A tuned absorber, consisting of a torsional spring, k_{t2} and a mass moment of inertia, J_2 is to be attached to the rotor to absorb the vibrations.

(a) Illustrate the rotor with the tuned absorber as a mass-spring system model.

[5 marks]

(b) Establish the values of k_{t2} and J_2 such that the natural frequencies of the system are away from the forcing frequency by at least 20 percent.

[15 marks]

(c) Show the improvement achieved in the amplitude of the rotor with the absorber by aid of a graph.

[5 marks]

PART B

Q4 (a) Explain briefly what is a Room Constant, R_c.

[4 marks]

(b) The Sound Intensity at a distance r meter from the source is given by:

$$I = P/4\pi r^2$$

where P is the power of the source and the threshold intensity, $I_{ref} = 10^{-12}$ W/m^2.

From the above equations, prove that the relationship between the Sound pressure level, SPL and the Sound power level, SWL is given by:

$$SPL = SWL - 20 \text{ Log } r - 8$$

(for non-absorbent ground or hemispherical radiation).

[7 marks]

(c) A generator with sound power level of 100 dB is radiating uniformly over a flat non-absorbent surface. Calculate the sound pressure level received by a worker at a distance of 15 m.

[7 marks]

(d) Determine the power output produced by a new machine which radiates uniformly into unobstructed space if the pressure at a distance of 5 m is 2 Pa.(assume ρc = 400 rayls).

[7 marks]

Q5 (a) Explain the Noise Reduction Coefficient, NRC and reverberation time, RT.

[4 marks]

(b) A classroom is located on the upper floor. It is 8m wide by 12m long by 3m high. The floor is vinyl tile on concrete, the walls are made of 1/2" drywall (gypsum) board, and the ceiling is acoustic tile suspended in frames. Approximate typical absorption coefficients of various surfaces are given in **Figure Q5**.

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

[6 marks]

(ii) Compare the reverberation time at 125Hz, 500Hz, and 2000Hz.

[10 marks]

(iii) What will happen to reverberation time if adding wood/metal seating and suggest one technique to greatly lower the reverb time.

[3 marks]

(iv) Give your comments on the reverberation time in when the musical instrument performance conducted in this room.

[2 marks]

Q6 A foreman's workstation is located inside a workshop with dimension of 40 m × 20 m × 8 m. The workshop wall is made of sheet metal roof and the wall is a concrete. The average room absoption coefficient, α_{mean} is 0.10. New exhaust fan with 99 dBA SWL to be located at end corner of the workshop with foreman's workstation is 4 m away. The existing noise level at foreman position is 88 dBA. The calculation chart for estimating sound pressure level in enclosed space is given in **Figure Q6**.

(a) What is the noise level at foreman's position with new exhaust fan in operation?

[10 marks]

(b) Asses the best position to locate the exhaust fan so that the foreman will only expose to the lowest noise level. Please assume the distance between the fan and the foreman is similar for all assessed position.

[9 marks]

(c) If the location of the exhaust fan cannot be changed, suggest two (2) actions each to control noise (i) at source, (ii) along sound transmission path and (iii) at receiver.

[6 marks]

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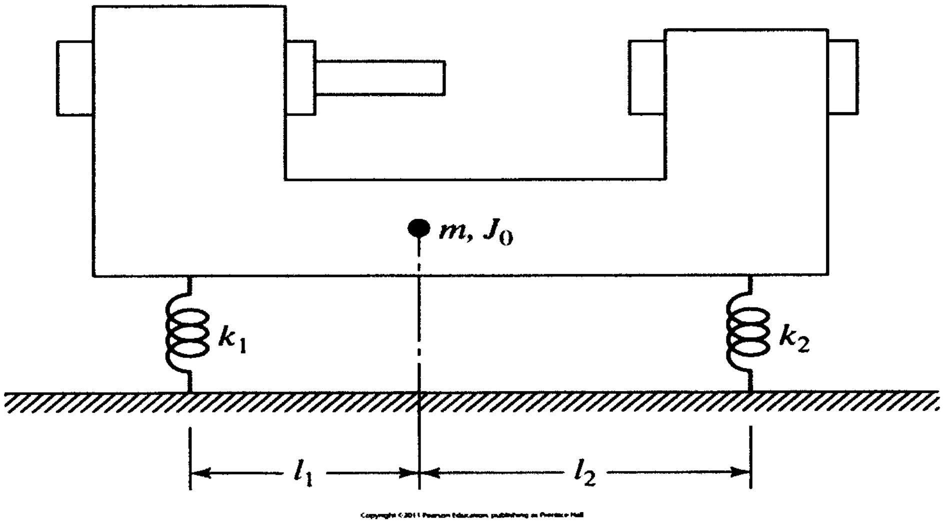

Figure Q1

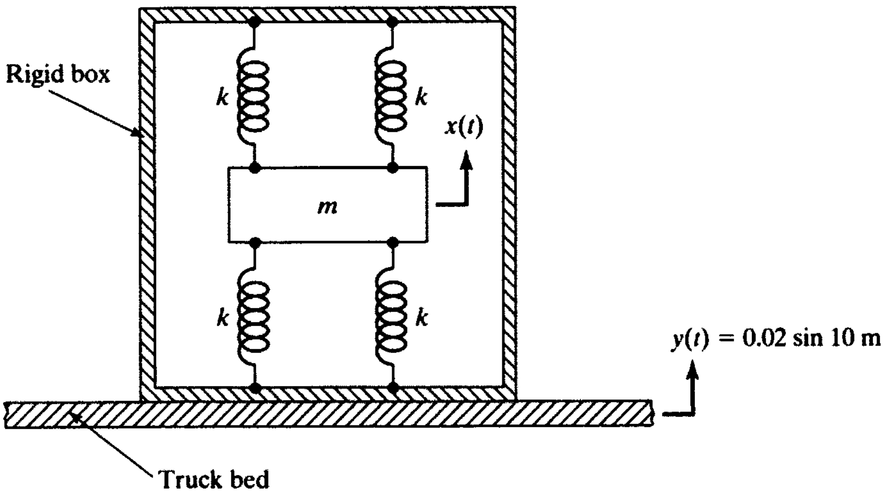

Figure Q2

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	Absorptivity at Frequency					
Surface Treatment	**125**	**250**	**500**	**1000**	**2000**	**4000**
Acoustic tile, rigidly mounted	.2	.4	.7	.8	.6	.4
Acoustic tile, suspended in frames	.5	.7	.6	.7	.7	.5
Acoustical plaster	.1	.2	.5	.6	.7	.7
Ordinary plaster, on lath	.2	.15	.1	.05	.04	.05
Gypsum wallboard, $\frac{1}{2}''$ on studs	.3	.1	.05	.04	.07	.1
Plywood sheet, $\frac{1}{4}''$ on studs	.6	.3	.1	.1	.1	.1
Concrete block, unpainted	.4	.4	.3	.3	.4	.3
Concrete block, painted	.1	.05	.06	.07	.1	.1
Concrete, poured	.01	.01	.02	.02	.02	.03
Brick	.03	.03	.03	.04	.05	.07
Vinyl tile, on concrete	.02	.03	.03	.03	.03	.02
Heavy carpet, on concrete	.02	.06	.15	.4	.6	.6
Heavy carpet, on felt backing	.1	.3	.4	.5	.6	.7
Platform floor, wooden	.4	.3	.2	.2	.15	.1
Ordinary window glass	.3	.2	.2	.1	.07	.04
Heavy plate glass	.2	.06	.04	.03	.02	.02
Draperies, medium velour	.07	.3	.5	.7	.7	.6
Upholstered seating, unoccupied	.2	.4	.6	.7	.6	.6
Upholstered seating, occupied	.4	.6	.8	.9	.9	.9
Wood/metal seating, unoccupied	.02	.03	.03	.06	.06	.05
Wooden pews, occupied	.4	.4	.7	.7	.8	.7

SOURCES: Backus (p. 172) and L. Doelle, *Environmental Acoustics* (McGraw-Hill, 1972), p. 227.

Table : Approximate typical absorption coefficients of various surfaces.

Figure Q5

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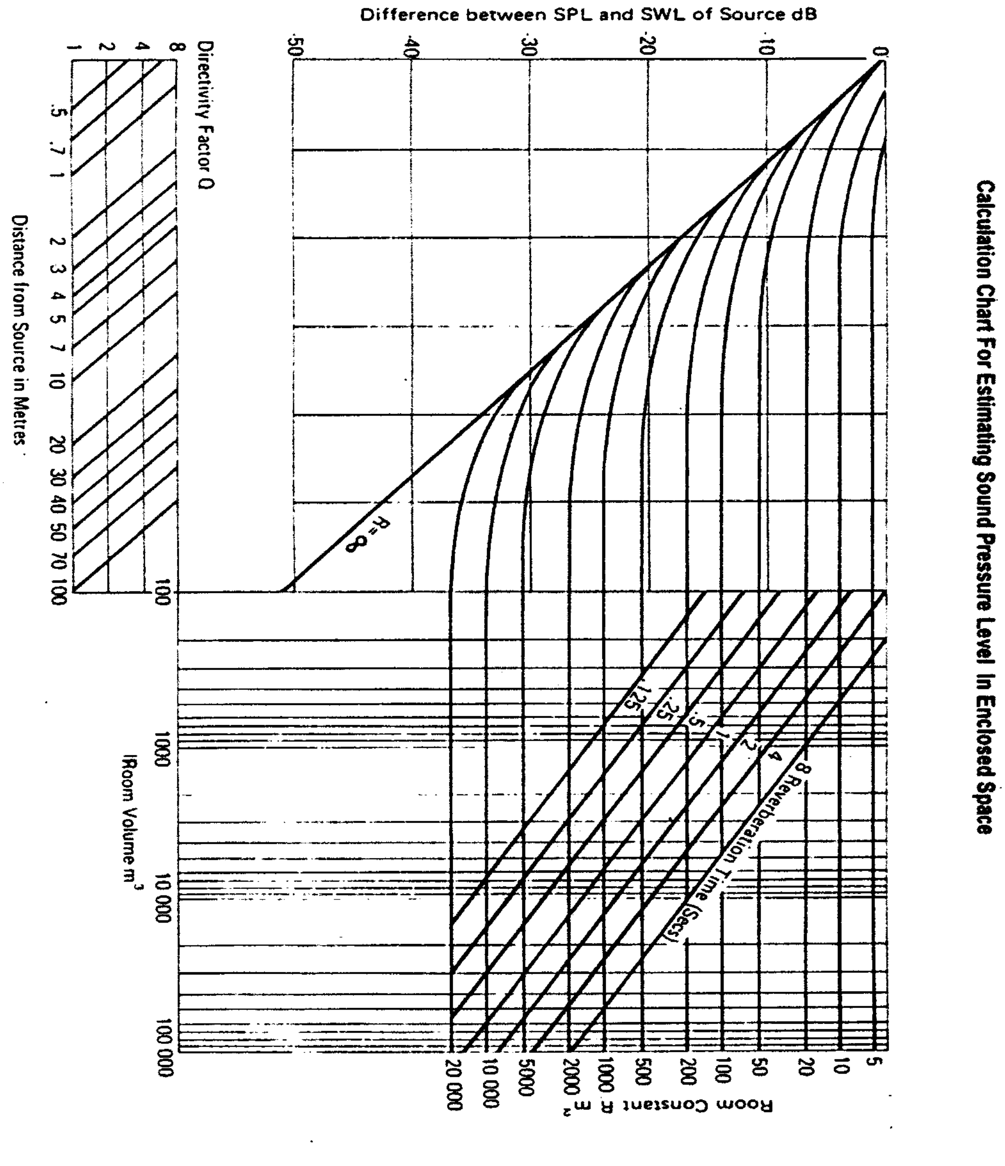

Figure Q6