Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 2
SESSION 2016/2017

COURSE	:	VIBRATION
COURSE CODE	:	BDA 31103 / BDA 40603
PROGRAMME	:	BDD
TEST DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	**PART A:** ANSWER **ALL** QUESTIONS **PART B:** ANSWER **TWO (2)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **SEVEN** (7) PAGES

PART A - ANSWER ALL QUESTIONS

Q1 (a) Describe any four (4) classification of vibration. Also states your understanding on the resonances terminology.

(6 marks)

(b) Vibration is the oscillatory motion of a machine or a machine component from its original place of rest. Differentiate the Displacement, Velocity and Acceleration terminologies in vibrations unit measurement. Give at least three (3) explanations for each terminology.

(9 marks)

(c) Vibration motion of a machine can be visually represented as a mass suspended by a coil spring. Sketch a complete oscillations "time vs displacement" graph for a general spring masses. State at the graph the position for maximum and minimum magnitude of velocity and acceleration individually.

(5 marks)

(d) Hand Arm Vibration Management and Control is necessary to prevent in such a desease of Carpal Tunnel Syndrome (CTS). Some of the risk assesment to workers may involve level, type and duration of exposure. Discuss five (5) safe work practices in order to prevent and control the risk of CTS.

(5 marks)

Q2 (a) Noise induce hearing loss is the most significant occupational diseases related with workers whom involved with machinery. You as an engineer had been given the task to reduce noise levels transmitted to worker. Briefly outline your approaches to control noise at workplace.

(6 marks)

(b) Understand the problem given and answer with suitable sound formula:

i. Differentiate the frequency of a sound wave with a wavelength of 2 m and 3 m. Assume the speed of sound is 340 m/s.

(4 marks)

ii. Analyze the sound pressure level when the rms pressure fluctuation is 0.5 Pa and 1 Pa.

(4 marks)

iii. Two machine give individual sound pressure levels at a particular workstation of 86 and 88 dB, respectively. What will be the sound pressure level when they are both switched on together?

(5 Marks)

(c) An employee is exposed to noise levels during the periods of the working day detailed in the **Table 1**. Determine this employee's 8 hours daily exposure, $L_{eq(8)}$.

Table 1

Task	Period	L_{eq}
Thicknesses	2 h	102 dB
Frame saw	30 min	96 dB
Band saw	1 h	85 dB
Router	3 h	93 dB
Panel saw	90 min	90 dB

(6 Marks)

PART B - ANSWER TWO QUESTIONS ONLY

Q3 A two degree of freedom mass-spring vibration system is shown in **Figure Q3**. Given, $m_1 = m$, $m_2 = 2m$ and $k_1 = k_2 = k_3 = k$.

(a) By using Newton's 2nd Law, formulate the equation of motion for the vibration system in matrix form.

(9 marks)

(c) Compare the modes of vibration for the vibration system by aid of mode shape diagrams.

(16 marks)

Q4 The vibration of an electric train made up of three cars can be modeled as a three degree of freedom system as shown in **Figure Q4**. The car body is connected by couplings of stiffness in function of the modulus E of the coupler. The equation of motion for the system is given below:

$$m\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}\ddot{x}_1\\ \ddot{x}_2\\ \ddot{x}_3\end{bmatrix}+\frac{EI}{l^3}\begin{bmatrix}3 & -3 & 0\\ -3 & 6 & -3\\ 0 & -3 & 3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}=\begin{bmatrix}0\\ 0\\ 0\end{bmatrix}$$

If $E = 6.9 \times 10^9$ N/m^2, $l = 2$ m, $m = 3000$ kg, and $I = 5.2 \times 10^{-6}$ m^4, differentiate between the 1st, 2nd and 3rd vibration modes characteristics of the system based on the mode shape diagrams.

(25 marks)

Q5 (a) Vibration absorber is a mechanical device used to reduce or eliminate unwanted vibration.

i. What is the difference between a vibration isolator and a vibration absorber?

(4 marks)

ii. Is it always advantages to include a damper in the vibration absorber? Justify your answer.

(2 marks)

(b) A reciprocating engine is installed on the first floor of a building, which can be modeled as a rigid rectangular plate resting on four elastic columns. The equivalent mass of the engine and the floor is 900 kg. At the rated speed of the engine, which is 600 rpm, the operators experience large vibration of the floor. It has been decided to reduce these vibrations by suspending an auxiliary mass (vibration absorber) from the bottom surface of the floor. By assuming the magnitude of the exciting force is 200 N, and the amplitude of motion of the vibration absorber is to be limited to 2 mm.

i. Analyze the parameters of the vibration absorbers (eg. mass and stiffness) to be mounted on the floor.

(8 marks)

ii. Compare the new natural frequencies of the system after the absorber is added. Support your answer with sketching.

(11 marks)

-END OF QUESTION-

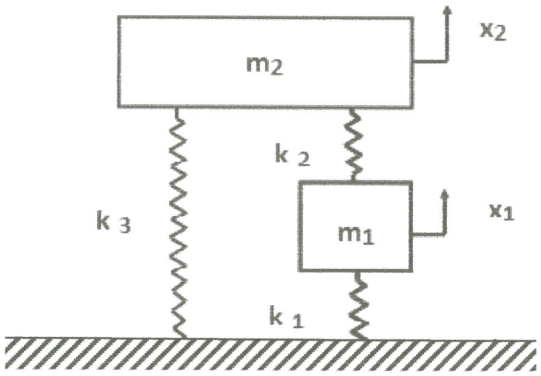
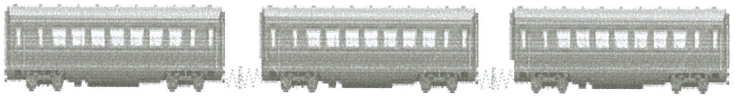
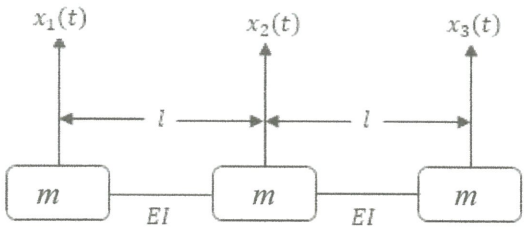


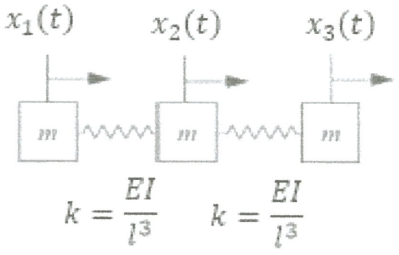
Figure Q3



(a) Electric train



(b) Coupler deflection model



(c) Spring-mass model

Figure Q4

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USEFUL FORMULAS:

Natural frequencies of the new system:

$$r_1^2, r_2^2 = \left(1 + \frac{\mu}{2}\right) \mp \sqrt{\left(1 + \frac{\mu}{2}\right)^2 - 1}$$

where $r_1 = \frac{\Omega_1}{\omega_2}$, $r_2 = \frac{\Omega_2}{\omega_2}$ and $\mu = \frac{m_2}{m_1}$