Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 1
SESSION 2017/2018

COURSE NAME	:	VIBRATION
COURSE CODE	:	BDA 31103
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	DECEMBER 2017 / JANUARY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	**PART A:** ANSWER **ALL** QUESTIONS **PART B:** ANSWER **TWO (2)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

PART A - ANSWER ALL QUESTIONS

Q1 (a) A motorcycle moving over a rough road can be modelled by considering:

- Mass of the motorcycle body as $m_{motorcycle}$, mass of rider as m_{rider}, mass of seat as m_{seat} and masses of front wheel and rear wheel as m_{wheel}.
- Elasticity of rider as k_{rider}, elasticity of tires as k_{tires}, elasticity of suspensions as $k_{absorber}$ and elasticity of seat as k_{seat}.
- Damping of the rider as c_{rider}, damping of seat as c_{seat}, damping of shock absorbers as $c_{absorber}$ and damping of tires as c_{tires}.

Identify the mass-spring damper models of the system by including all the component mentioned above.

(4 marks)

(b) Experimental modal analysis deals with the determination of the natural frequencies, damping ratios and mode shapes through vibration testing. Select the necessary equipment to perform the modal analysis and justify your selection. Sketch the diagram of equipment.

(8 marks)

(c) Hand-arm vibration syndrome (HAVS) is the preferred name for the condition caused by prolonged exposure of hand-arm system to mechanical vibration. Vibration-Induced White Fingers (VWF) and Carpal-Tunnel Syndrome (CTS) are the two common diseases related to hand-arm vibration syndrome.

(i) Provide two comparison between the Vibration-Induced White Fingers (VWF) and Carpal-Tunnel Syndrome (CTS)

(8 marks)

(ii) An employee uses a hand tool for approximately 3 hours a day. An acceleration of 1.2, 6.4 and 9.7 ms^{-2} for the x, y and z axes is measured at the handle while it is in use. Analyze the 8 hours exposure level, A(8) of the employee.

(5 marks)

Q2 (a) Distinguish between decibel (dB), decibel A weighted (dB(A)), dose and equivalent sound level (L_{eq})

(4 marks)

(b) A sound pressure level of 90 dB(A) was observed at a 5 m distance from the source. The measurement environment is at the hard surface ground (an empty parking lot). Calculate the sound power of the source.

(8 marks)

(c) Estimate the dose and equivalent sound level (L_{eq}) for measurement and actual time duration. Show the result of L_{eq} in three (3) and five (5) exchange rate. Conclude whether the noise level exceed permissible exposure limit (PEL > 90 dB(A)) as per mention in Factories and Machinery (Noise Exposure) Regulation 1989. List below is the detail information during noise personal monitoring:

- Dose for one (1) cycle of intermittent noise is 15% and employee exposed to 20 cycles for 8 hours.
- Work shift start from 7.00 am to 4.30 pm
  - Morning tea break start from 10.00 am to 10.15 am
  - Lunch break start from 12.00 pm to 1.00 pm
  - Evening tea break start from 3.00 pm to 3.15 pm

(13 marks)

PART B - ANSWER TWO QUESTIONS ONLY

Q3 A two degree of freedom vibration system is shown in **Figure Q3**.

(a) By using Newton's 2nd Law, compute the natural frequencies of the system if $m_1 = m_2 = 1$ kg, $k_1 = 2000$ N/m, and $k_2 = 6000$ N/m.

(7 marks)

(b) Examine the effect of the initial condition of the system on the responses $x_1(t)$ and $x_2(t)$ for the following conditions:

i) $x_1(0) = 0.2\text{m}, \dot{x}_1(0) = x_2(0) = \dot{x}_2(0) = 0$

ii) $x_1(0) = 0.2\text{m}, \dot{x}_1(0) = x_2(0), \dot{x}_2(0) = 5\text{m}$

(18 marks)

Q4 A three coaches train system shown in **Figure Q4(a)** can be simplified as a three degree of freedoms semi definite mass-spring system as illustrated in **Figure Q4(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.

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

(7 marks)

(ii) Differentiate between the 1st, 2nd and 3rd vibration modes characteristics of the train system based on the mode shape diagrams.

(18 marks)

Q5 (a) Explain two differences between vibration isolator and vibration absorber.

(4 marks)

(b) An air compressor of mass 50 kg operates at 1200 rpm. Assuming that the damping ratio of the shock isolator is 0.1 and providing that 75 percent vibration isolation to the base;

i. Determine the static deflection produced by the isolator

(10 marks)

ii. If shock isolator of compressor is replacing with the isolator consisting of a similar spring stiffness with neglible damping, compare the force transmitted to the base before and after the isolator replacement by assuming that compressor produces 50 N force. Justify your answer.

(11 marks)

-END OF QUESTION-

FINAL EXAMINATION

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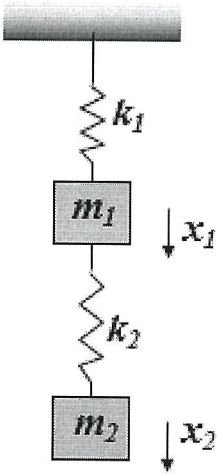

Figure Q3

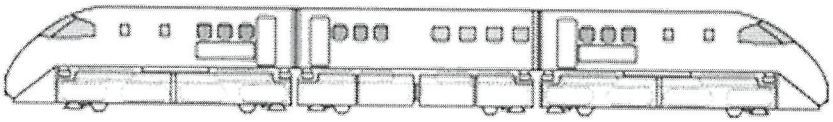

Figure Q4(a)

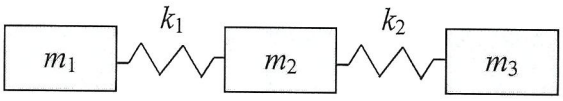

Figure Q4(b)