Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(TAKE HOME)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	VIBRATION AND NOISE IN RAILWAY
COURSE CODE	:	BNT 20303
PROGRAMME CODE	:	BNT
DATE	:	JANUARY/FEBRUARY 2021
DURATION	:	6 HOURS
INSTRUCTION	:	ANSWER **ALL (FOUR)** QUESTIONS **OPEN BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 A set of motor-generator with weight of 210 kg is designed to operate in the speed range of 2800 to 3300 rpm. However, the generator set is found to vibrate violently at a speed of 3000 rpm due to a slight unbalance in the rotor. As an engineer, you have been instructed to design an undamped vibration absorber attached to the system to eliminate the problem. The trial mass of vibration absorber given to you is 5.5 kg.

(a) Analyze the vibration absorber performance whether it can eliminate the vibration induced by motor-generator set or not. Please justify your answer.

(12 marks)

(b) It is required to re-design the vibration absorber by taking an upper natural frequency 3400 rpm (which fall outside the operating speed range of motor-generator set) as a benchmark, evaluate the new parameters of vibration absorber by specifying its mass and stiffness. Please justify your answer whether the re-design vibration absorber is safe to be used or not?

(i) Evaluate the new parameters of vibration absorber by specifying its mass and stiffness.

(10 marks)

(ii) Justify your answer whether the re-design vibration absorber is safe to be used.

(3 marks)

Q2 A schematic model of seismograph system is illustrated in **Figure Q2**: device to records earthquakes. Assuming that θ is too small for the model, and given $g = 9.81$ m/s^2 and the initial conditions of the system are $(0) - 0.3$ m, $\dot{x}(0) - \theta(0) - \theta(0) = 0$.

(a) Derive the equations of motion of the system in matrix form with complete values by using Lagrange formula. $[M]\begin{Bmatrix}\ddot{x}\\ \ddot{\theta}\end{Bmatrix}+[K]\begin{Bmatrix}x\\ \theta\end{Bmatrix}=\begin{Bmatrix}0\\ 0\end{Bmatrix}$

(10 marks)

(b) Analyze the natural frequencies of the system.

(5 marks)

(c) Determine the free vibration responses of the system, $x(t)$ and $\theta(t)$ by including all the given initial conditions.

(10 marks)

Q3 A number degree of freedom system depend on the number of mass and number of movement either translation, rotation or torsional at each axis. A system is said to undergo free vibration when it's oscillates only under an initial disturbance with no external forces acting after initial disturbance.

(a) Demonstrate the free vibration response of $5\ddot{x} + 160x - (t)$ in the form of $x(t) = A_1 \cos \omega_n t + A_2 \sin \omega_n t$ with initial condition of; $x\ (1) = 0.02\ m$ and $\dot{x}(1) = 0.5\ m/s$.

(4 marks)

(b) Differentiate between three types of free vibration damped system with roots formula condition and diagram.

(6 marks)

(c) (i) Test the amplitude of steady state motion for single degree of freedom with harmonic excitation with different value of damped system which is c – 500 Ns/m and c – 0 Ns/m. The value of spring stiffness, k is 1000 N/m, mass, m is 100 kg and harmonic excitation, F is $100\cos 5t$.

(4 marks)

(ii) Draw the diagram system

(2 marks)

(d) Examine the natural frequencies and mode shapes for the torsional system shown in **Figure Q3(d)**. The value for J_1 – 10 kgm^2, J_2 – 20 kgm^2 and $k_{t1} = k_{t2} = 1$ N/m. Assume harmonic motion of $\theta(t) = A \sin(\omega t + \phi)$.

(9 marks)

Q4 (a) Any motion that repeats itself after an interval of time is called vibration or oscillation. Demonstrate **TWO (2)** typical examples of vibration and interpret general energy conservation concept of vibratory systems.

(5 marks)

(b) The minimum number of independent coordinate required to determine completely the positions of all parts of a system at any instant of time defines the number of degrees of freedom of the system. Distinguish between linear and angular coordinate for single, two and three degree of freedom systems with diagram explanation.

(6 marks)

(c) The measurement of the input and the resulting output vibration characteristics of a system helps in identifying the system in term of its mass, stiffness and damping. Illustrate the basic features of a vibration measurement scheme.

(5 marks)

(d) Hand arm vibration is a physical hazard which transmitted to worker hand during operating hand held machine. During occupational vibration monitoring, a workers from grinding operation had been exposed to hand arm vibration with the acceleration value of 6.30 m/s^2 at x-axis, 2.59 m/s^2 at y-axis and 2.67 m/s^2 at z-axis.

(i) If the worker only expose to vibration for a duration of 2 hours per day and assume the working duration per day is 8 hours. Examine the vibration total value, a_{hv} and daily vibration exposure, A(8).

(6 marks)

(ii) Justify whether the daily vibration exposure exceed exposure limit value of 5 m/s^2.

(3 marks)

- END OF QUESTIONS

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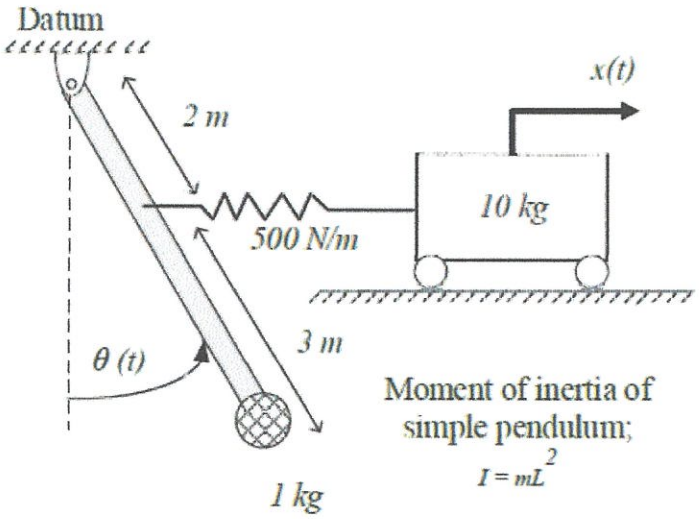

Figure Q2

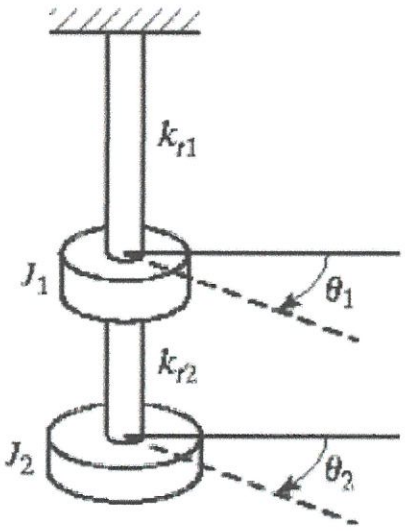

Figure Q3(d)