

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION SEMESTER II SESSION 2013/2014

COURSE NAME

: NOISE AND VIBRATION

COURSE CODE

: BDA40603

PROGRAMME

: 4BDD

EXAMINATION DATE

: JUNE 2014

DURATION

: 3 HOURS

INSTRUCTIONS

: ANSWERS TWO (2) QUESTIONS FROM

PART A AND TWO (2) QUESTIONS

FROM PART B

THIS PAPER CONTAINS OF NINE (9) PAGES

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PART A: ANSWER ALL QUESTIONS

- Q1 (a) FIGURE Q1(a) illustrates a two degree of freedom pendulum systems
 - (i) Derive the motion equations of motion of the system

(5 marks)

(ii) Obtain the frequency equation if $\theta(t) = \Theta \sin(\omega t + \theta)$

(5 marks)

(iii) Calculate the natural frequency if a = 1 m, m = 1 kg and k = 1 kN/m

(3 marks)

(b) Free body diagrams of the body of the vehicle and the seat drawn at arbitrary instant are shown in **FIGURE Q1(b)**. Use Lagrange's equation to derive the motion equation of the system.

(12 marks)

Q2 (a) Explain briefly on the two types of hearing impairment.

(4 marks)

(b) Describe the noise control at the receiver. You should also include the attenuation graph of hearing protectors and Noise Reduction Rating.

(5 marks)

(c) The sound pressure level (SPL) at a receiver position,r is governed by the equation, $SPL = SWL + 10 \log ((Q/(4\pi r^2)) + (4/R_C))$

Where, SWL is the sound power level. If the directivity factor, Q = 8, the mean absorption coefficient of the room, $\alpha_{\text{mean}} = 0.10$ and the room total surface area, $S = 2560 \text{ m}^2$. Determine;

(i) the room constant, R_C

(4 marks)

(ii) the direct sound loss factor if the receiver's position is 4 m from the source.

(4 marks)

(iii) the reverberant sound loss factor.

(4 marks)

(iv) the room radius, r.

(4 marks)

PART B: ANSWER TWO (2) QUESTION ONLY

| Q3 | Three wheels are connected by two shafts as shown in FIGURE Q3 above, k1=k2=1 and |
|----|--|
| | J1=J2=J3=1. By using Holzer method |

(a) Start with ω = 0.5 and Θ =1, list in the table system J_i and Θ_i and find the total tork of the wheels

(6 marks)

(b) with ω = 1.0 and Θ =1, list in the table system J_i and Θ_i and find the total tork of the wheels

(6 marks)

(c) with ω = 1.5 and Θ =1, list in the table system J_i and Θ_i and find the total tork of the wheels

(6 marks)

(d) Determine the natural frequency by using linear interpolation

(7 marks)

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Q4 (a) Explain the three components of a general noise system.

(5 marks)

(b) A reverberant room has dimensions of 6 m by 10m by 4 m high. The measured reverberation time for the room is 3.50 seconds. The air in the room is at 300K (27°C) and 101.3 kPa, at which condition the speed of sound is 347.2 m/s. The measured sound pressure level in the 500 Hz octave band due to the noise from pump in the room is 65 dB. Determine the sound power level for the pump in the 500 Hz octave band.

(7 marks)

(c) Two panels of glass, each having a thickness of 6mm, are to be used to reduce the sound transmission through an opening 1.00m high and 2.00m wide. The panels are spaced 75mm apart, and the air around the panels is at 24° C, for which c = 345.6 m/s. The surface absorption coefficient for the glass is $\alpha = 0.03$. Given transmission loss for a single panel of glass is 24.2dB for 250Hz and 36.2dB for 1000Hz. Determine the transmission loss at the following frequencies of 250 Hz and 1000 Hz.

(13 marks)

Q5 (a) An employee works 1 hour where the sound level is 90 dBA. The worker inspects gauges and other items for 2 hours where the sound level is 92 dBA. A total of 3 hours is spent in an area around a compressor where the sound level is 94 dBA. The remaining 2 hours are spent in a relatively quiet office area where the sound level is 60 dBA. Is this employee's noise exposure in violation of the OSHA regulations?

(10 marks)

(b) An air vent located outdoors produces the noise spectrum shown in **TABLE Q5(a)**. The vent noise is broadband, and the sound is not impulsive. The vent operates about 30 times each hour, 1 minute duration, during the daytime and the evening, but not during the nighttime. The vent operates year-round. The vent is located in an area with light industry. Determine the environmental noise rating and the anticipated community reaction to the vent noise as given by **TABLE Q5(b)** and **TABLE Q5(c)**.

(15 marks)

-END OF QUESTION-

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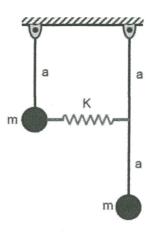


FIGURE Q1(a)

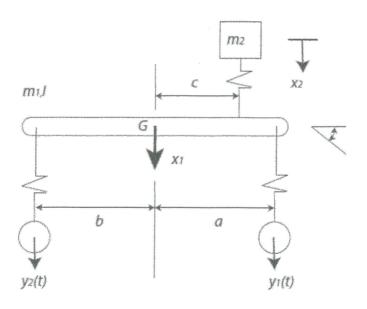


FIGURE Q1(b)

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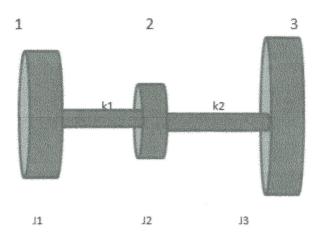


FIGURE Q3

TABLE Q5(a): The noise spectrum of an air vent located outdoors

| | Octave band center frequency, Hz | | | | | | | |
|--------------------------------|---|-----|---|---|-----------|-------|-----------------|-------|
| | 63 | 125 | 250 | 500 | 1,000 | 2,000 | 4,000 | 8,000 |
| $L_{\rm p}({\rm OB}),{\rm dB}$ | 43 | 50 | 55 | 61 | 66 | 69 | 71 | 69 |
| N_0 , dB | production of the last of the | 33 | 46 | 58 | 66 | 71 | 75 ^a | 74 |
| $L_{\rm CNR}$ -65 | 86 | 78 | 72 | 68 | 65 | 63 | 60 | 59 |
| Reduction, dB | | | *************************************** | *************************************** | - Parkers | 6 | 11 | 10 |

^aLargest value.

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TABLE Q5(b): Correction Factors (CF) for Various Influencing **Factors for Community Noise Reaction**

| Influencing factor | Possible condition | CF, dB |
|--------------------|---|-------------------------------------|
| Noise spectrum | Noise with pure-tone components Broadband noise | +5 |
| Repetitiveness | Continuous to 1/minute 10–60 times/hour 1–10 times/hour 4–24 times/hour 1–4 times/day 1 time/day | 0 -5 -10 -15 -20 -25 |
| Time of day | Daytime only (7:00 a.m. to 6:00 p.m.) Evening (6:00 p.m. to 10:00 p.m.) Nighttime (10:00 p.m. to 7:00 a.m.) | -10 -5 0 |
| Season of the year | Winter only Summer (and winter) | |
| Type of area | Rural Suburban Urban residential Residential with some business Area with light industry Area with heavy industry | +10 +5 0 -5 -10 -15 |
| Peak factor | Impulsive sounds Non-impulsive sounds | +5 |

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TABLE Q5(c): Average Community Reaction to Noise Based on the Composite Noise Rating L_{CNR}

| Corrected composite noise rating, L_{CNR} , dB | Community response | Percent of population complaining | | |
|---|-------------------------|---|--|--|
| 39 dB or less | No reaction | | | |
| 40-45dB | Mild annoyance | 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 | | |
| 46-50 dB | Sporadic complaints | 2 | | |
| 51-55dB | Widespread complaints | 7 | | |
| 56-69 dB | Threats of legal action | 12 | | |
| 70 dB or greater | Vigorous legal action | 22 | | |

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