UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
SEPTEMBER 2014 SESSION

SUBJECT CODE : FCD20402
SUBJECT TITLE : ACOUSTIC AND VIBRATION
LEVEL : DIPLOMA
TIME / DURATION : 3.30 PM – 5.30 PM
(2 HOURS)
DATE : 08 JANUARY 2015

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer two (2) question only.
6. Answer all questions in English.
7. Formula is appended.

THERE ARE 6 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.
SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions. Please use the answer booklet provided.

Question 1

a) What is the airborne sound? (6 marks)

b) What is the direct airborne sound? (7 marks)

c) What is the structure – borne sound? (7 marks)

Question 2

a) What is “Speed and Wavelength”? (4 marks)

b) What are the general characteristics of sound? (8 marks)

c) A compressor is radiating a pure tone of 1000Hz. If speed of sound is 1125ft/s and 343 m/s. What is the wavelength of 1000 Hz? (8 marks)
Question 3

a) What is “sound Power”?

(2 marks)

b) What is “sound pressure”?

(2 marks)

c) Referring to figure Q3(c), determine the value of radius \( r_1 \) when

Sound pressure level \( L_{p1} \) is 60dB and sound power level \( L_w \) at the

source for free field condition

(16 marks)

Figure Q3(c): Sound pressure distance
SECTION B (Total: 40 marks)

INSTRUCTION: Answer only TWO questions.
Please use the answer booklet provided.

Question 4

Refer to figure Q4,
Calculate the Sound pressure level (SPL) radiating from an Air conditioning unit received by a worker at the distance of 6m from the Air conditioner. The Air conditioner is installed at the middle of angle of the room of 17.5m x 12.5m x 4.0m. The Air conditioner manufacture specification of the Sound power level (SWL) is 80 dB. The background noise of the room is 70dB and radius from fan coil to reservoir.
The room is constructed by concrete wall, ceiling and floor absorption coefficient of
Door : 1.0m x 2.5 m
Window: 2.5m x 1.5m

\[ \alpha_{\text{wall}} = 0.1 \]
\[ \alpha_{\text{floor}} = 0.2 \]
\[ \alpha_{\text{ceiling}} = 0.15 \]
\[ \alpha_{\text{window}} = 0.25 \]
\[ \alpha_{\text{Door}} = 0.1 \]

Calculate:

a) Total absorption area

b) Average absorption coefficient

c) Room constant

d) Reverberation time

e) Total Sound pressure level (Lp)
Figure Q4: Indoor unit location
Question 5

(a) What is the definition of:
   i. The Coefficient or factor of reflection (r)?  
      (2 marks)
   ii. The Coefficient or factor of absorption (α)?  
       (2 marks)
   iii. The Coefficient or factor of transmission (t)?  
        (2 marks)

(b) State the formula of:
   i. Natural frequency  
      (2 marks)
   ii. Transmissibility  
      (2 marks)

(c) Referring figure Q5(a) and(b). A 50kg block moves vertically with two spring in different condition. The block is pulled 40mm downward from its equilibrium position and released. Find the natural frequency for (a) and (b).  
    (10 marks)

Figure Q5(a): Complete system with parallel spring
Figure Q5(b): Complete system with series spring
Question 6

A tray of mass $m_1 = 50\text{kg}$ is attached to 3 springs as shown in figure Q6(a). The natural frequency is 3.18Hz. After that, another $m_1$ block has been placed on top of the first $m_1$ and spring B is removed, as figure Q6(b) now the natural frequency is observed to be 1.6Hz. Determine the spring stiffness of $k_A$ and $k_B$.

(20 marks)

Figure Q6(a): Complete system with all Spring A and B installed

Figure Q6(b): After spring B is remove And additional $M_1$

END OF QUESTION
Formulae:

- \( \log(ab) = \log a + \log b \)
- \( \log(a/b) = \log a - \log b \)
- \( \log a^b = b \log a \)
- \( \log_a a = 1 \)
- \( \log_a 1 = 0 \)
- \( \log_a b = \log_c b / \log_c a \)

ACOUSTICS:

- \( \lambda = \frac{\nu}{f} \) where \( \lambda \) = wavelength, \( \nu \) = speed (m/s); \( f \) = frequency (Hz)
- \( v = \sqrt{\frac{RT}{M}} \)
  
  Where \( R = \frac{\overline{R}}{M} \), \( M \) = Molar Mass; \( \overline{R} \) = Universal Gas constant (8.314 kJ/kmol.K)
- For Air: \( v = \sqrt{\frac{RT}{M}} \approx 20.04 \sqrt{T} \) where \( T \) in Kelvin
- \( T(K) = 273 + ^\circ C \)
- \( L_w = 10 \log \left( \frac{W}{W_{ref}} \right) \) where \( W_{ref} = 10^{-12} \) watt
- \( L_p = 20 \log \left( \frac{P}{P_{ref}} \right) \) where \( P_{ref} = 20 \) Pa
- \( L_I = 10 \log \left( \frac{I}{I_{ref}} \right) \) where \( I_{ref} = 10^{-12} \) watt/m²
- \( L_{TOTAL} = 10 \log \left[ \sum_{i=1}^{n} 10^{L_i/10} \right] \)
- \( L_{p1} - L_{p2} = 20 \log \left( \frac{r_2}{r_1} \right) \)
- **Free Field**: \( L_p = L_w + 10 \log \left( \frac{Q}{4 \pi r^2} \right) \) where \( Q \) = Directivity (1, 2, 4, 8)
- **Closed Room**: \( L_p = L_w + 10 \log \left( \frac{Q}{4 \pi r^2 + \frac{4}{R}} \right) \)
where $R =$ Room constant; $R = \frac{S - \bar{\alpha}}{(1 - S\bar{\alpha})}$; absorption coeff. $\alpha_{abs} = \frac{I_{abs}}{I_{inc}}$;

$S = S_1 + S_2 + S_3 + \ldots + S_n$.

Reverberation time in sec $T_\infty = \frac{0.16V}{A}$, where $V =$ Room volume,

Total absorption area (TSA) $A = \sum S_i \alpha_i$