Document No : UniKL MFI_SD_AC41
Revision No: 02
Effective Date: 01 December 2008

CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2014 SESSION

SUBJECT CODE	:	**FCB20102**
SUBJECT TITLE	:	**VIBRATION**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**12.45pm - 2.45pm** **(2 HOURS)**
DATE	:	28 MAY 2014

INSTRUCTIONS TO CANDIDATES

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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. Answer all questions.
6. Answer all questions in English.
7. Fomula and Table of Supporting Documents are Appended (RETURNABLE)

THERE ARE 3 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

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

Question 1

Define the following concept:

(a) Damped Frequency

(b) Resonance

(4 marks)

Question 2

Refer to figure Q2. You are given with the motor-spring system as below. Ignore any friction.

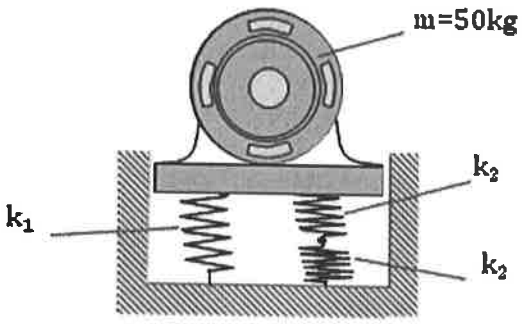

Figure Q2: Simple vibration system

The motor mass is 50kg. The attenuation required for the system is 95% and the motor speed is 1 000 rpm.

Calculate:

(a) the natural frequency of the system in Hz and rad/sec

(4 marks)

(b) the value of each spring stiffness k_2 in kN/m if the spring stiffness k_1 is 2kN/m.

(6 marks)

Question 3

Refer to Figure Q3. It was found that the amplifying vibration of the front grill cover of the indoor split unit have to do with the 50Hz AC Fan Motor onto the blower which accidently having 50Hz natural frequency.

Explain

(a) the effect of the above system

(5 marks)

(b) how to reduce the vibration

(5 marks)

(c) how to prevent the amplifying vibration

(6 marks)

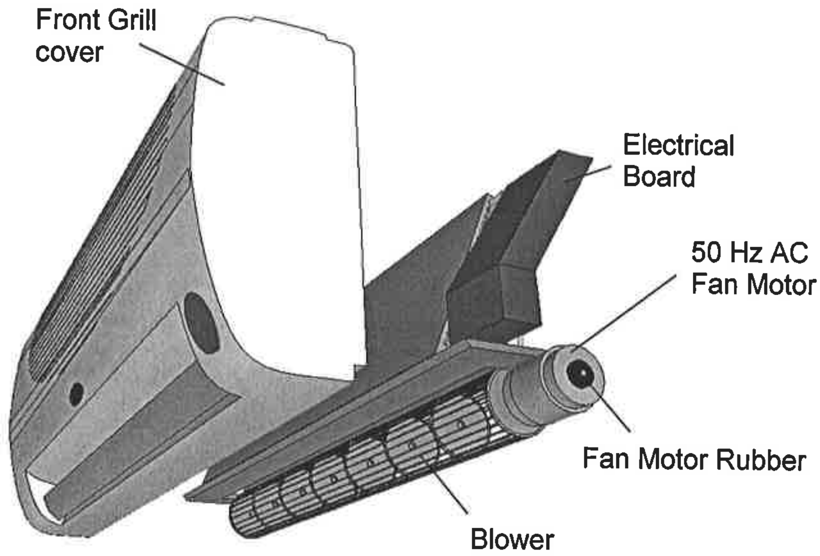

Figure Q3: Indoor split Unit

Question 4

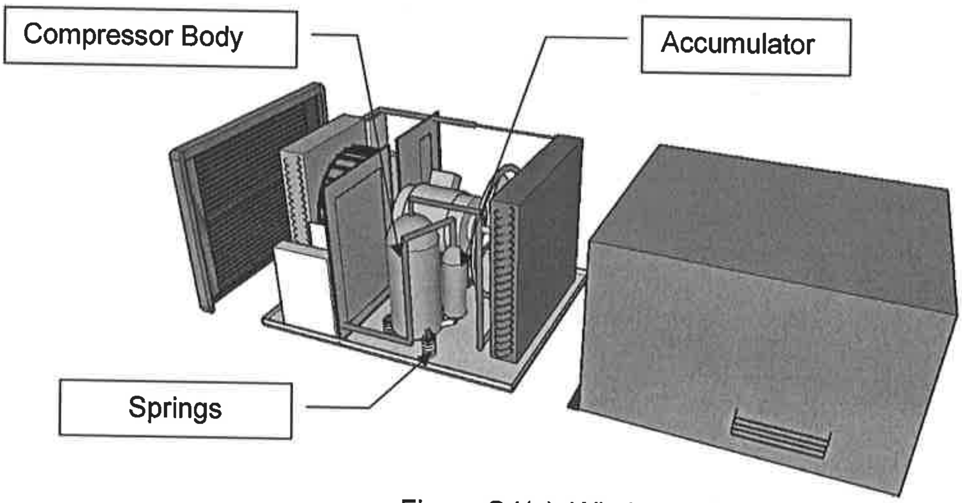

Figure Q4(a): Window unit

Figure Q4(a), Q4(b) and Appendices. The dimensional details of its assembly are as shown in figure Q4(b). The system needs to be attenuated (vibration isolation efficiency) by 90%.

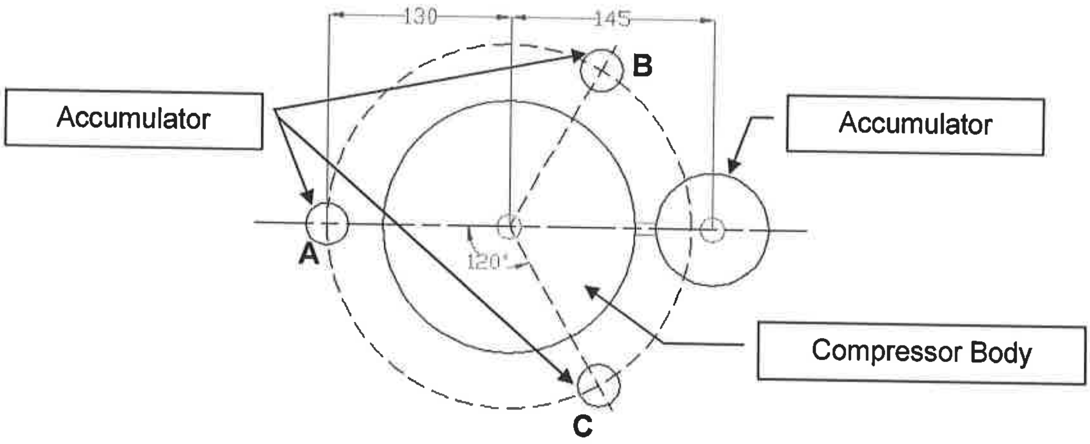

Figure Q4(b): Details Dimensions of window unit

The system specification is as follows:

Power supply	=	240V-1∅–50Hz
Compressor body	=	12 kg
Compressor Rotational Speed, N	=	1 500 rpm
weight of Accumulator	=	0.5 kg

(Note: Let 10% as Safety Factor (S.F) for the final weight calculation)

For the spring mounting at **corner C only**:

(a) Calculate the spring static deflection δ_{st} in(mm) and spring stiffness k in (N/m)

(20 marks)

(b) Refer to the Appendices, select the closest suitable spring at B

(10 marks)

END OF QUESTION

APPENDICES

VIBRATION:

- $x = x_m \sin[f_n t + \phi]$
- $P = \left[x(0), \frac{\dot{x}(0)}{f_n} \right]$
- $x_m = \sqrt{[x(0)]^2 + \left[\frac{\dot{x}(0)}{f_n} \right]^2}$
- $\phi = \tan^{-1}\left(\frac{x(0)}{\frac{\dot{x}(0)}{f_n}} \right)$
- $f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{15.8}{\sqrt{\delta_{ST}}}$ where $\delta_{ST}\_in\_mm$
- $\tau = \frac{x_m}{\delta_{ST}} = \left| \frac{1}{1 - \left(\frac{f_d}{f_n}\right)^2} \right|$ where $\tau = transmissibility$
- $\tau = \frac{x_m}{\delta_{ST}} = \frac{1 + \left(2\varepsilon \frac{f_d}{f_n}\right)^2}{\sqrt{\left[1 - \left(\frac{f_d}{f_n}\right)^2\right]^2 + \left[2\varepsilon \frac{f_d}{f_n}\right]^2}}$ where

  $\varepsilon = \frac{c}{c_o}, c_0 = critical\_damping$
- $x_m = \frac{\delta_m}{1 - (f_d / f_n)^2}$
- $\tan\varphi = \frac{c \times f_d}{k - m f_d^{\ 2}} = \frac{2(c/c_o)(f_d/f_n)}{1 - (f_d/f_n)}$

  $v_m = x_m f_n, a_m = x_m f_n^{\ 2}$
- $velocity: v = \varpi r, where\_\varpi = 2\pi(in\_radian), Note: 2\pi(rad) = 360° = 1rev$

  $a_t = \alpha r = \ddot{\theta} r, a_n = \varpi^2 r$
- $Centrifugal\_Force = F_n$

  $F_n = \frac{mv^2}{r}; F_n = m\varpi^2 r$
- $A = 1 - \tau$ where $A = Attenuation(Vibration\_Isolation\_efficiency)$
- $N\,(rpm) = \frac{(2 \times Freq)}{Poles} \times 60\ sec/min \times \eta_m$