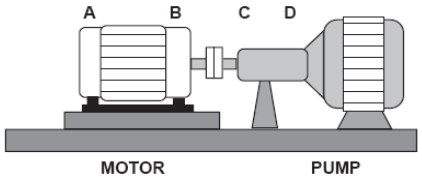
AMERICAN UNIVERSITY IN CAIRO
MECHANICAL ENGINEERING DEPARTMENT

MENG 475
Lab 2: Vibration Severity

Objective
The objective of this lab is to understand the term "vibration severity" and the precautions necessary to the assessment of vibration severity in a machine, in accordance with the international standard ISO 10816-1 1995*. The concept of machine condition monitoring is introduced. A portable accelerometer is used to measure the vibration levels of a machine. The results are used to assess the vibration severity of an air conditioner pump unit.

Equipment
- Portable accelerometer
- Building air conditioning pump

Background
Rotating machinery, such as the motor—pump unit shown, are very common in the industry. A practicing mechanical engineer is often faced with duty of maintaining the safe operation of these units in order to avoid delays or accidents. Preventive maintenance is essential to guarantee the sound and long-life operation of machines. Maintaining vibration levels below specified acceptable limits is a measure of preventive maintenance. Once vibrations exceed these limits, it becomes necessary to cease operation, and carry out detailed trouble-shooting vibration measurements, where the major vibration frequencies are identified to provide insight to the sources of vibration. Corrective measures are then taken to minimize or, if possible, eliminate these vibrations. The above process is referred to as *machine condition monitoring*.



Monitoring the levels of vibration or vibration severity therefore provides the basis for the decision to employ detailed troubleshooting vibration measurements. Vibration severity is defined as *a comprehensive and simple characteristic unit for describing the vibratory state of a machine*. According to ISO 10816, it is common practice, based on experience, when evaluating broad-band vibration of rotating machinery to consider the *RMS value of vibration velocity*" as the unit of measurement for indicating vibration severity.

- The validity of the rules provide by the above ISO standard is restricted to vibrations measured at machine surfaces, and within the frequency range 10-1000 HZ and the speed range 10-200 rev/s.
- Examples of these types of machines include electric motor and pumps, generators, steam and gas turbines, turbo-compressors and fans.
- Points of measurement are chosen where the vibration energy is transmitted to the resilient mountings or to other parts of the system. For machines including rotating masses, the bearings and mounting points are the preferred points of measurement.
- Succeeding vibration severity ranges have a ratio of 1:1.6 giving a step of 4dB between severity levels. A difference of 4dB represents a significant change in the vibratory response in most machines. Examining the vibration criterion chart will show that an increase of 8dB (about 2.5 times) in the vibration level will move the condition from 'good' to 'allowable', to 'just tolerable', to 'not permissible'.
- A machine must be classified into a particular machine class before its vibration severity can be assessed.

It is worthwhile to conduct trend comparisons, to compare the current values of vibration levels at the same points over a period of time, or to make mutual comparisons with other existing machines.

* ISO vibration severity standard 10816: "Mechanical vibration—Evaluation of machine vibration by measurements on non-rotating parts".

Experimental Procedure

Measure the vibration levels at the feet of the machine in order to assess the vibration severity. There are several machines that can be used in the pump room of the building's air conditioning system. An assessment of the vibration severity should then be concluded from the measurements and documented in a technical report.

The table below shows the vibration severity criterion chart, taken from ISO 10816. The chart specifies machinery vibration limits based on machine power and foundation type. The criteria are based upon the RMS value of vibration velocity for operating speeds of 600 to 12,000 rpm.

Vibration Severity According to ISO 10816					
Machine		Class I Small	Class II Medium	Class III Large, Rigid Foundation	Class IV Large, Soft Foundation
	mm/s				
RMS Vibration Velocity	0.28	A	A	A	A
	0.45				
	0.71				
	1.12	B			
	1.8		B		
	2.8	C		B	
	4.5		C		B
	7.1	D		C	
	11.2				C
	18		D	D	
	28				D
	45				

A: Good, B: Allowable, C: Just tolerable, D: Not permissible

<u>Machinery class designations are as follows:</u>

Class I: Individual parts of engines and machines, integrally connected with the complete machine in its normal operating condition. (Production electrical motors of up to 20 HP (15 kW) are typical examples of machines in this category.)

Class II: Medium-sized machines typically, electric motors with 20 to 75 HP (15-75 kW) without special foundations, rigidly mounted engines, or machines on special foundations up to 400 HP (300 kW).

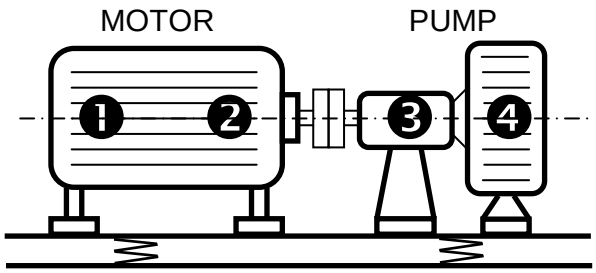
Class III: Large prime movers and other large machines with rotating masses mounted on rigid and heavy foundations which are relatively stiff in the direction of vibration measurement.

Class IV: Large prime movers and other large machines with rotating masses mounted on foundations which are relatively soft in the direction of vibration measurement (for example, turbo-generator sets, especially those with lightweight sub-structures).

Report

The report should include a description of the measurements taken and how they were taken, the measured values of RMS vibration velocity, the vibration severity, and the concluded assessment of vibration severity.

Document your readings for each machine in the following format:

Sketch of machine	Machine
	Speed and power
	Special features
	Measuring instrument
	Location

	1	2	3	4	Limit values
Horizontal					1_____ 2_____
Vertical					3_____ 4_____
Axial					☐ mm/s ☐ μm

Machine class according to ISO 10816	
Quality judgment	☐ Good ☐ Allowable ☐ Just tolerable ☐ Not permissible