# VIBRATION ANALYSIS OF ELECTRIC SHAVER MECHANICAL SYSTEM USING STATISTICAL ANALYSIS METHOD

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# Faculty of Mechanical and Manufacturing Engineering Technology

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**A thesis submitted**
**in fulfillment of the requirements for the degree of**
**Bachelor of Mechanical Engineering Technology (Maintenance) with Honours**



**Faculty of Mechanical and Manufacturing Engineering Technology**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2022**

**DECLARATION**

I declare that this Choose an item. entitled "Vibration Analysis Of Electric Shaver Mechanical System Using Statistical Analysis Method" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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| Signature | : | |
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| Date | : | 11/2/2023 |

**APPROVAL**

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Maintenance) with Honours.

Signature : Irman

Supervisor Name : *Ts. MOHD IRMAN BIN RAMLI*

Date :

# DEDICATION

To my beloved parents, family member, supervisor, and friends

# ABSTRACT

Condition-Based Maintenance (CBM) is a maintenance technique that assesses an asset's current state to determine what maintenance is needed. Vibration analysis is one sort of condition maintenance. The goal of vibration analysis is to discover whether the equipment is degrading before it breaks down. Vibration Monitoring is a type of condition-based monitoring that includes listening to vibrations in a running piece of equipment to see if there are any aberrant vibration patterns. Because variations in vibration levels can indicate advanced wear and a variety of other issues, such as equipment falling free from mountings or malfunctioning parts, vibration monitoring is a vital aspect of good asset integrity management. This study will conduct vibration analysis on an electric shaver. It is possible to increase the life of an electric shaver by monitoring its vibration. Numerous approaches may be utilized to locate and eliminate the defect of an electric shaver. The data acquired during vibration inconsistency monitoring can be utilized to design predictive maintenance operations. The accelerometer sensor captured a vibration signal, which was used to collect data. Using the Fast Fourier Transform, the vibration signal produced by the dynamic response of a combustion engine was studied (FFT). To obtain accurate data, all the captured data is filtered using MATLAB. To interpret the data collected from the experiment, the data were evaluated using statistical analysis methods. The result that has been collected will be compared and decide which has a better performance.

## *ABSTRAK*

Penyelenggaraan Berasaskan Keadaan (CBM) ialah teknik penyelenggaraan yang menilai keadaan semasa aset untuk menentukan penyelenggaraan yang diperlukan. Analisis getaran adalah satu jenis penyelenggaraan berasaskan keadaan. Matlamat analisis getaran adalah untuk mengetahui sama ada peralatan merosot sebelum ia rosak. Pemantauan Getaran ialah sejenis pemantauan berasaskan keadaan yang termasuk mendengar getaran dalam peralatan yang sedang berjalan untuk melihat sama ada terdapat sebarang corak getaran yang menyimpang. Oleh kerana variasi dalam tahap getaran boleh menunjukkan kehausan lanjutan dan pelbagai isu lain, seperti peralatan yang terlepas daripada pemasangan atau bahagian yang tidak berfungsi, pemantauan getaran merupakan aspek penting dalam pengurusan integriti aset yang baik. Kajian ini akan menjalankan analisis getaran pada mesin pencukur elektrik. Adalah mungkin untuk meningkatkan hayat pencukur elektrik dengan memantau getarannya. Pelbagai pendekatan boleh digunakan untuk mencari dan menghapuskan masalah pada pencukur elektrik. Data yang diperoleh semasa pemantauan ketidakkonsistenan getaran boleh digunakan untuk mereka bentuk operasi penyelenggaraan ramalan. Sensor pecutan menangkap isyarat getaran, yang digunakan untuk mengumpul data. Menggunakan Fast Fourier Transform, isyarat getaran yang dihasilkan oleh tindak balas dinamik enjin pembakaran telah dikaji (FFT). Untuk mendapatkan data yang tepat, semua data yang ditangkap ditapis menggunakan MATLAB. Untuk mentafsir data yang di kumpul daripada eksperimen, data telah dinilai menggunakan kaedah analisis statistik. Hasil yang telah di kumpul akan dibandingkan dan memutuskan yang mana mempunyai prestasi yang lebih baik.

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## TABLE OF CONTENTS

## LIST OF TABLES

# LIST OF FIGURES

## LIST OF SYMBOLS AND ABBREVIATIONS

| | | |
|---|---|---|
| D,d | - | Diameter |
| MATLAB | - | Matrix Laboratory |
| RMS | - | Root Mean Square |
| STDDEV | - | Standard Deviation |
| CBM | - | Condition-Based Maintenance |
| DC | - | Direct Current |
| VCM | - | Vibration Condition Monitoring |
| FFT | - | Fast Fourier Transformation |

## LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Vibration in a definition is a periodic back-and-forth motion of a particle. Basically, vibration is when a particle goes on one side from a position and returns back then it goes to the other side and again returns back, then it is known as one vibration. Vibration also can be described as a motion of a particle about a fixed point. In engineering, vibrations are oscillations in mechanical dynamic systems. Vibration is important in engineering because vibration may influence the durability and reliability of mechanical systems or structures and cause problems such as damage, abnormal stopping, and catastrophic failures.

In maintenance, vibration can be used to detect machine failures to expand the machine's life span. There are many different types of vibration tests. Some involve field measurement while the structure is in its normal operational state. These tests can be performed for a wide range of reasons such as vibration monitoring to determine a machine's suitability for operation (Kenneth, 1995). Machine failures can be drastically reduced by adopting a preventive maintenance tool program, which can also be known as a condition-based maintenance system. Condition-Based Maintenance (CBM) is a maintenance strategy that monitors the actual condition of an asset to decide what maintenance needs to be done. One type of condition maintenance is vibration analysis. The aim of vibration analysis is to determine the deteriorating condition of equipment before it leads to a breakdown.

Vibration can be caused by one or more factors at any given time, the most common being imbalance, misalignment, wear, and looseness. Uncheck machine vibration can accelerate rates of wear and damage equipment. Vibration can cause injuries in humans, with 'white fingers due to long term exposure to vibration. Vibration also can cause noise, unpleasant sound, which causes annoyance as well as disease discomfort (Anders Brandt, 2011)

By studying the vibration in an electric shaver, it can contribute in extending its life span. To find and eliminate the faulty of electric shaver, there are many several methods can be used. By studying vibration in electric shaver, perhaps it can increase knowledge on how maintenance procedure work in industry that using much bigger machine.

## 1.2 Problem Statement

Electric shaver is a motorized small electrical device for cutting body hair. An electric shaver is a razor with an electrically powered rotating or oscillation blade powered by a small DC motor, which is powered by batteries or mains electricity. The DC motor can cause vibration in the electric shaver. Abnormal vibration in an electric shaver can be a sign of damage and faulty. By study the vibration, we can determine it faulty and find a solution to maintained it.



## 1.3 Research Objective

1) To study the common faulty in electric shaver using vibration signal analysis with different parameters.
2) To analyse the data collected using Matrix Laboratory (MATLAB) and Vibration Spectrum Analysis.

## 1.4 Scope of Research

In relation to the objective of the study, the scope of the study is to focus on different battery that supply power to electric shaver. Secondly, to measure between normal and faulty electric shaver. And lastly to measure the electrical shaver performance by using vibration statistical analysis.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Vibration

Vibration is a self-repeating motion. It can be defined as the conversion of kinetic energy to potential energy, implying that there must be energy storage and release in a vibratory system. A mass and a spring may easily mimic this type of motion. The spring is in charge of potential energy in this system, while mass is in charge of kinetic energy. Vibrations come in a variety of forms. The basic mechanical elements and associated force equations are presented in Figure 2.1. In these force equations, x denotes displacement, and the dots on the top of variable x denote derivatives about time; hence, x_ and x denote velocity and acceleration, respectively.



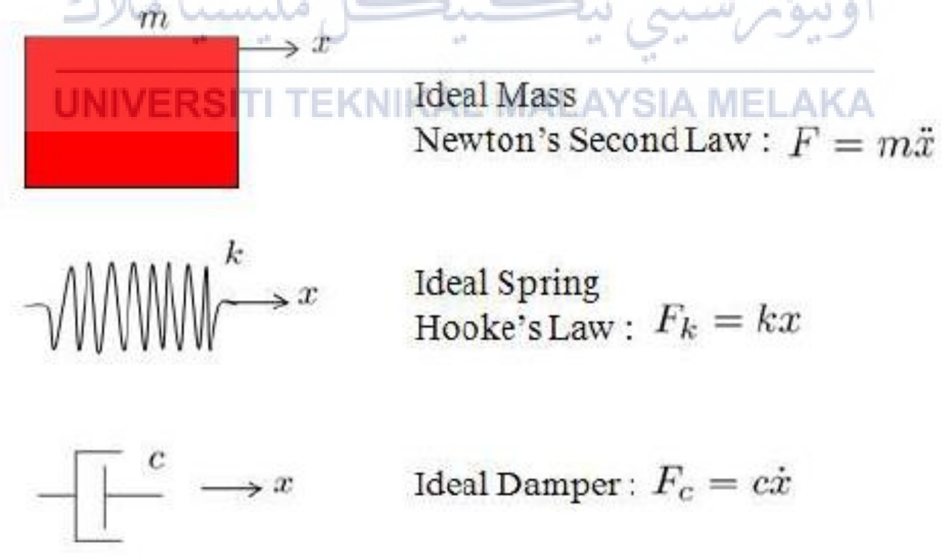


Figure 2.1 Mechanical elements

## 2.2 Vibration Sensor

Vibration sensors come in a variety of shapes and sizes, including displacement sensors, velocity sensors, and accelerometers. Because they are simple, easy to use, and sensitive to the high-frequency vibrations created during force failure, accelerometers are the optimum choice for most industrial rotating assets.

The machine-mounted sensor is essential for vibration monitoring and analysis. The displacement, velocity, and acceleration are the three parameters that vibration monitors use to represent motion. These metrics are theoretically linked and can be calculated using a variety of motion sensors. The frequency of interest and the signal levels involved influence the choice of a sensor proportional to displacement, velocity, or acceleration.

### 2.2.1 Velocity sensor

Low to medium frequency measurements are made with velocity sensors. They can be used for vibration monitoring and balancing on rotating machines. Velocity sensors have a lesser sensitivity to high frequency vibrations than accelerometers, making them less susceptible to amplifier overloads. The fidelity of low amplitude, low frequency signals can be harmed by overloads. The velocity signal is generated by a traditional velocity sensor using an electromagnetic (coil and magnet) technology. Due to their enhanced capabilities, more durable piezoelectric velocity sensors (internally integrated accelerometers) are becoming more common.

Figure 2.3 Seismic transducer

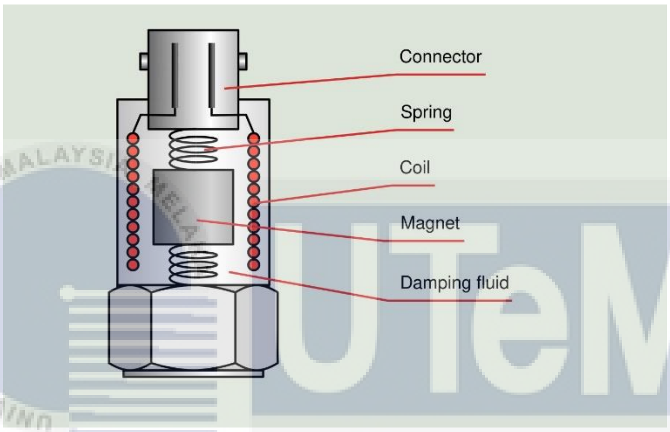


Figure 2.2 Seismic transducer components



### 2.2.2 Accelerometer

The great majority of accelerometers on the market today can be divided into three kinds. Piezoresistive, piezoelectric, and capacitive are the three types of accelerometers. Although other transduction methods for acceleration detection exist, such as thick-film strain gauge, optical/displacement, tunnelling, resonator, electromagnetic force balance and electrostatic force balance (G.A. MacDonald, 1990), most of the research and advances in the accelerometer field to date have focused on the first three types. Each of these three types of accelerometers has its own set of benefits and drawbacks, resulting in a distinct market and need for each. The type of accelerometer chosen for the task will be influenced by the details of the specific accelerometer application. Size, weight, cost, performance, operating frequency, sensitivity, signal level, temperature range, resonant frequency, impedance, damping, mounting considerations, bandwidth, linearity, hysteria, cross-axis sensitivity, stability, material fatigue, shock resistance, electronic requirements, self-testability, mass producibility, and manufacturability are all factors to consider when choosing an accelerometer.

The piezoelectric accelerometer (Henry, 1989) is the second type of accelerometer. A seismic mass is mounted on a piezoelectric crystalline material, which is then fixed to the sensor frame in the most basic construction for a piezoelectric accelerometer. The seismic mass exerts a force (F=m a) on the piezoelectric material as the sensor accelerates, causing it to distort.

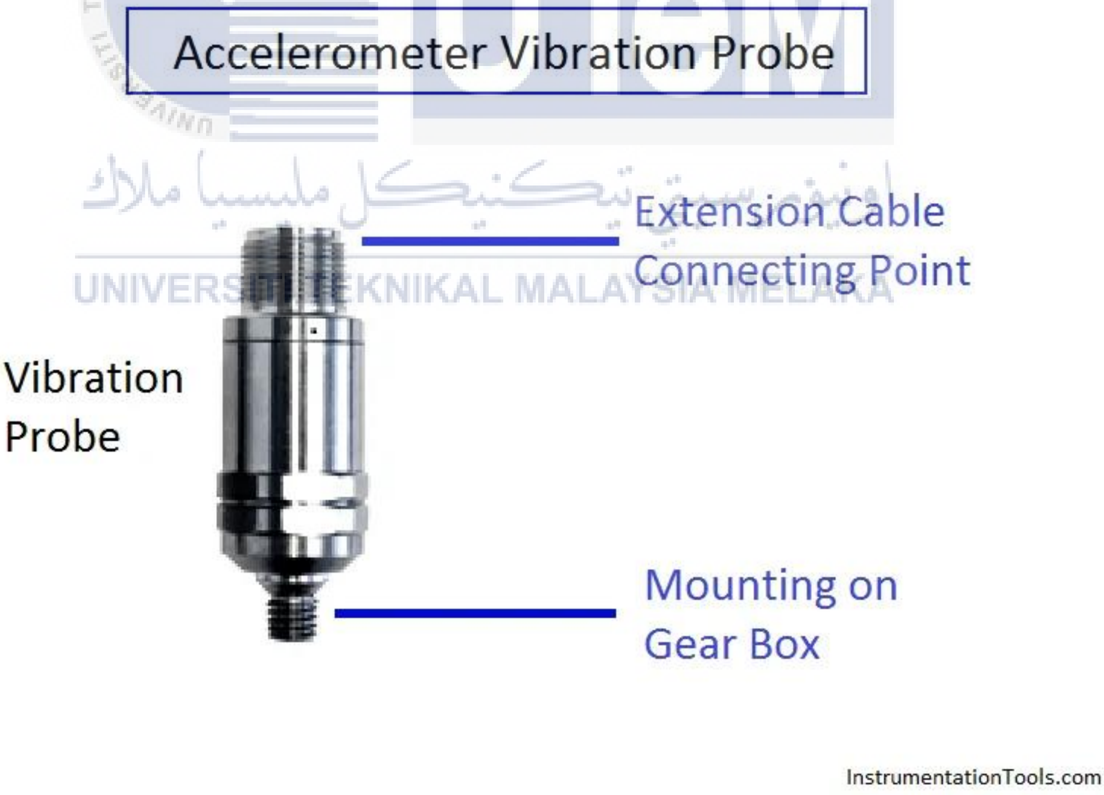




Figure 2.4 Accelerometer Vibration Probe

(Source: https://instrumentationtools.com/accelerometer-vibration-probe-principle/)

## 2.3 Typical VCM (Vibration Condition Monitoring) Process

Rotating machines are at the centre of most industrial activities, and a significant number of industrial failures are frequently linked to one or more rotating machine components. A rotating machine is basically an assemblage of several components (e.g., bearings, shafts, gears, couplings, impellers, blades, and so on) with at least one of these components subjected to rotational motion to facilitate the achievement of a defined operational aim (T.Backström, 1997). Compressors, induction motors, fans, turbogenerators, bucket elevators, belt conveyors, drag chains, crushers, drills, pumps, and other rotating machinery are among the most regularly utilised across various industries. Because spinning machinery are so important, different degrees of precision are required. Over time, new designs and complications have emerged. Due to increased failure modes, these complexities and sophistications enhance their proneness to failure.

The consequences of rotating machinery' (particularly the Failures in industries can range from brief outages to long-term outages. Stoppages that are both disastrous and lasting, with frequently major consequences on manufacturing, finance, safety, and the environment (T.Backström, 1997). Because rotating machines are the backbone of most operations, it's critical to develop robust and dependable systems for detecting and diagnosing any developing defects so that downtime is kept to a minimal. Over the years, one of the most common methods of extending the duration between rotating machine failures has been to use a rotating machine (P. Jayaswal, 2011). VCM is gaining popularity, maybe because of alarming figures stating that up to 20-40% of fatalities and unscheduled outages can be traced back to vibration (J.H. Hamilton, 1977).

VCM is a subset of the CM maintenance philosophy that uses vibration-based approaches to determine the true state of machines and structures so that maintenance decisions (repair or replace) can be made based on identified deviations from normal operating circumstances. Through the prevention of unexpected or abrupt failures, a properly implemented VCM programme has the potential to drastically reduce maintenance costs. The three basic stages commonly found in a typical VCM process (A.K.S Jardine, 2006).

### 2.3.1 Data collection

The monitoring and storing of vibration data is the first step in a typical VCM process for rotating machinery. This VCM stage usually includes the installation of several instruments, which may alter slightly depending on the rotation depending on the complexity and type of fault However, the majority of VCM systems Transducers, signal conditioners, and analogue-to-digital converters are frequently required. provides a way to save the detected vibration data for later analysis. A transducer, often known as a sensor, is an instrument that can convert changes in physical variables into an electrical signal. The vibration signals measured by transducers from spinning machinery are typically analogue signals that must be digitised before being accepted by future storage systems (usually a personal computer system).



This digitization is achieved through the aid of an analogue-to-digital converter (ADC). Sometimes, the range of the signals measured by the transducer may exceed or fall short of the requirements of the ADC. Therefore, the incorporation of a signal conditioning unit is always desired. Signal conditioning units perform various functions, including the provision of required power to the transducers as well as the amplification or attenuation of the measured signal, to ensure adequate compatibility between measured signal range and the requirements of the ADC. As indicated by Equation (2.1), all vibrating components have three classes of closely related properties (acceleration, velocity, and displacement) according to vibration theory. As a result, the availability of any of these characteristics can