SUPERVISOR’S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

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Date : ............................................................
STUDENT’S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature : ..................................................
Name : MOHD HANAFFI OTHMAN
ID Number : ME 07004
Date : ..................................................
To my beloved parents

SEMEK@HASMAH BINTI MAMAT

To my supervisor
Madam Mas Ayu binti Hassan

To my Academic Advisor
Mr. Muhamad Zuhairi Sulaiman

To all FKM’s staffs and lecturers

To all my classmates

And To my Special friend out there
Siti Norsyahinas Binti Che Man

Thank you for your supporting and teaching.

Thank you for everything that you gave during studies and the knowledge that we shared.
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Cam is a mechanical component that translates movement from circular to reciprocating by using mating component, called the follower. The principal aim of this work is to study and analysis the vibration factor on vertical position cam using heart shape cam. Then, verifies the data using DYNACAM simulated and analysis the effect of impact force on vibration in cam follower system. The parameters such as displacement, velocity and acceleration are involved in finding the optimum force to the system of vibration cam in high speed rotation per minute (RPM). The analysis process will be done using DYNACAM simulation software that able to verify the results from obtained the experiment whether the data are correct or not for principal of vibration in cam follower system. The analysis process also focus on the jump force of follower, that effect of vibration factor in cam mechanism system. During analysis data will be process, high speed will be select from the types of speed of cam in follower system. The speeds that will be used are 300RPM and it is suitable for analyze the vibration factor and more accurate. When high speeds system pumping chemically processed air can have gradually applied loads.
ABSTRAK

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LIST OF SYMBOLS

Cam Angle Rotation

Angle of Rotation

Follower Displacement

Instantaneous Follower Velocity

Instantaneous Follower Acceleration

$\Delta R$  Instantaneous Follower Displacement At Time

Speed of the Cam

$K$  Spring Stiffness

Deflection

$F$  Force

Mass of Follower

Damping Coefficient

Natural frequency
CHAPTER 1

INTRODUCTION

1.1 Project Background

Cam is an element of the cam-follower mechanical system that compels the movement of the follower by direct contact (Horald A. Rothbart, 2004). Cam is a mechanical component that translates movement from circular to reciprocating by using mating follower. A cam can be defined as a device that having a curved outline or a curved groove that usually called as cam profile. A common example is the camshaft of an automobile, which takes the rotary motion of the engine and translates it into the reciprocating motion necessary to operate the intake and exhaust valves of the cylinders. The cam mechanism may be modeled as a three mass system (leading element, cam and follower) with three degrees of freedom (displacement of the leading element, cam and follower). Due to complexity of such a model, usually, the mechanism is divided into two systems: leading element-camshaft-cam system and cam-follower system which are considered as one-degree-of-freedom systems.

The motion of the follower is the result of the program. Just as a computer program, so is a cam. Thus, the system can be thought of as a mechanical information device. Accordingly, the goals of the designer is to build a program, establish the locus of the contact point between the cam and follower, produce the cam profile coordinate system, and fabricate the cam within an acceptable accuracy. After all the parts are assembled the performance of the cam-follower system is observe. (Horald A. Rothbart, 2004).
There are three types of cam followers, and each type of the follower influences the profile of the cam. The three types are the knife-edge, the roller follower and the flat face follower. The follower restraint to the cam is positive-driven by the use of rollers in the cam groove or multiple conjugate cams, is spring-loaded, or occurs by gravity.

In the cam-type transfer unit, transferring motion, which consists of feeding, lifting and clamping, is actuated by the feed cam, lift cam, and clamp cam, respectively. Cam is mechanism that can reliably perform a repetitive and complex motion at high velocity. The feed cam, lift cam and clamp cam are equipped to one shaft, which is synchronized with the pressing motion of the press machine. Therefore, it is ensure that the transportation system taken outside than die path before the tools are closed.

The most of the journal consider the vibrations of the cam-follower system which is assumed as an oscillator with a mass and a spring. The return system of the follower contains a spring and a damper. The oscillator is excited with the function of shape of the cam which depends on the angle of rotation of the cam. This basic model is extended including the Columb friction at the rocker arm pivot and the Hertzian contact between the follower and cam. To reduce the sensitivity of the follower motion on the parameter variations the optimal design methods for cam curve are developed. Unfortunately, the results are obtained by omitting the influence of the camshaft and leading element.
1.2 Problem statement

One of the many potential problems with unwanted vibrations in high-speed machinery is the possible introduction of follower jump in a cam-follower mechanism. Jump is a situation where the cam and follower physically separate. When they come back together the impact introduces large forces and thus large stresses, which can cause both vibrations and early failure of the mechanism. Many companies are now conducting in-depth vibration analyses on their existing machines and redesigning many stations to reduce the overall vibrations in the machine.

1.3 Objective

1.3.1 Study and analysis the vibration factor and verify using DYNACAM 1998 Simulation

1.3.2 Analysis the effect of impact force on vibration in cam follower system

1.4 Scope

A study was conducted to find the optimum equation of motion for the system from the dynamic model. The equation relates the cam displacement, velocity and acceleration to analyze and prove the vibration system of cam follower. The velocity, acceleration and displacement also involved to investigate the optimum force to the cam system on vibration in high speed rotation per minute (RPM).
CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Cam is a versatile, specially shaped part of a machine that is always in contact with a member a called the follower. The name cam should not be confused with the common abbreviation cam for camera and camcorder, both used in the fields of photography and video, nor with the acronym CAM applied to computer applied to computer-aided manufacturing, which utilizes computational facilities for machinery fabrication of all kinds.

Many different types of cam profile are designed and manufactured depending on a machine’s requirements (P.W Jensen, 1987). Cam is a part of a rotating wheel or shaft that strikes a lever at one or more points on its circular path. The cam is in most cases merely a flat piece of metal that has had an unusual shaped or profile machined onto it.

Many studies on the cam mechanisms concern the problem of vibrations. As machine speed increases the problem of vibrations of the cam mechanism has the more significant importance. The vibration level has the influence on the wear rate, noise level and service life of the cam actuated machines and devices and also to the precision operation of machines. Because of that it is important to understand the cause of vibrations and provide means to control or to minimize unwanted vibrations so that desirable system response characteristics may be predicted and obtained.
Cam follower mechanism are found in almost all mechanical device and machine for example in agriculture, transportation equipment, textiles, packaging, machine tools, printing press, automobile internal combustion engines, food processing machines, switches, ejection molds, and control systems, and more recently in micro machines such as micro electromechanical system[MEMS]. Figure 2.1 showed the automobile cam-driven overhead valve train linkage.

![Automobile cam-driven overhead valve train linkage](image)

**Figure 2.1** Automobile cam-driven overhead valve train linkage  

The motion of the follower as a function of cam curve and parameters of the cam-mechanism are determined. The special attention is given to analysis of the cam velocity, damping properties of the camshaft and mass ratio of the follower and cam. As an example the vibrations of the cam mechanism with polynomial cam-curve are investigated.

The mechanism consists of a leading element, an elastic cam-shaft, a heavy cam and an elastic follower. The leading force and the force of the follower act. If the shaft which connects the leading system and the cam is rigid, the model is a system with one degree of
freedom. The generalized coordinate is the displacement of the cam. The cam has a profile which causes the follower to move in certain manner. The differential equation of motion is the second order, non-linear and with time variable coefficients one. For some parameters of the cam mechanism the differential equation of motion is with small parameters. Then the approximate analytic solution of the equation is obtained.

For the small velocity of cam motion in comparison the other parameters (approximately 0.5) the strong non-linear differential equation with slowly varying parameters is solved using the elliptic-Krylov-Bogolubov method. Analyzing the obtained solution it is obvious that the amplitude of vibrations depend on the velocity of cam motion and the relation between the masses of the follower and the cam. For higher velocity of cam motion the accuracy of follower motion is smaller. It is recommended the mass of the cam to be decreased in comparison to the mass of the follower. The amplitude variation depends on the cam profile, too.

The vibration properties of the system depend on the parameters of the mechanism. The damping properties of the cam-shaft have a significant influence on the vibrations of the system. For higher values of the damping coefficient of the connecting shaft the vibrations of the mechanism are smaller and the motion of the follower differs only a bit from the projected theoretical one. Namely, for higher damping coefficient the motion of the follower is much more accurate than for smaller damping coefficient.