



**AIN SHAMS UNIVERSITY**  
**FACULTY OF ENGINEERING**  
**DESIGN AND PRODUCTION ENGINEERING DEPARTMENT**

# **DIAGNOSIS OF COMMON MECHANICAL FAULTS IN ROTATING MACHINERY**

**BY**

**Eng. Mohammed Mohammed Taha Hedaya**  
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**Supervised by**

**Prof. Dr. Mohamed Abdel Salam Aly**  
Design & Production Engineering Department,  
Faculty of Engineering,  
Ain Shams University.

**Dr. Mostafa Rostom Ahmed Atia**  
Design & Production Engineering Department,  
Faculty of Engineering,  
Ain Shams University.

**Cairo, Egypt**  
**(2009)**

## EXAMINERS COMMITTEE

**Examiner**

**Signature**

**Prof. Dr. Sabet R. Ghabrial**

Professor in Design & Production Engineering Department.

.....

Ain Shams University, Faculty of Engineering

**Prof. Dr. Mohamed Kamal Mohamed Bedawy**

Professor in Mechanical Design & Production Engineering Department.

.....

Cairo University, Faculty of Engineering

**Prof. Dr. Mohamed Abdel Salam Aly**

Professor in Design & Production Engineering Department.

.....

Ain Shams University, Faculty of Engineering

# **STATEMENT**

This thesis is submitted to Faculty of Engineering, Ain Shams University for the degree of M.Sc. in Mechanical Engineering (Design and Production Engineering).

The work included in this thesis was carried out by the author in Department of Design and Production Engineering, Faculty of Engineering, Ain Shams University, Cairo, in the period (2006 to 2009).

No part of the thesis has been submitted for a degree or qualification at any other University or Institute.

Date : April., 2009

Signature :

Name : Mohammed Mohammed Taha Hedaya

## C.V.

Name : Mohammed Mohammed Taha Hedaya  
Date of Birth : 30 March 1984.  
Present Position : Teaching Assistant, Design and Production Engineering  
Department, Faculty of Engineering, Ain Shams  
University, Cairo, Egypt.  
Education : B.Sc., Mechanical Engineering (Production), Faculty of  
Engineering, Ain Shams University, 2005.  
Education grade : Distinction  
Project grade : Distinction

# **ABSTRACT**

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Four types of mechanical faults in rotating machinery are considered, namely: misalignment faults (parallel and angular), unbalance faults (static, couple and dynamic), localized gear fault and localized ball bearing faults (in outer race and in inner race). Theoretical study for the nature and frequency of the vibration resulting from each of these faults is presented. The faults were artificially created in special test rig constructed for this purpose. The rig was used to study the nature and frequency of the vibration resulting from each fault experimentally. The natural frequencies of the rig were determined by the finite element method to avoid rig operation near a resonance frequency. Experiments were carried out at different loads. A data acquisition system and a signal analyzer were used to save and analyze the vibration signals measured by accelerometers. For advanced processing of data, such as amplitude demodulation and determination of the envelope spectrum, computer programs were developed. The vibrations were measured at the seat of the bearing which was highly affected by the fault under consideration. In the cases of unbalance faults, vibrations were measured at the bearings carrying the unbalanced rotor simultaneously, to determine the phase angle between these vibrations, which distinguishes different types of unbalance (static, couple and dynamic). The coupling between the vibrations of these bearings was considered. Results showed the following: (1) Misalignment faults cause periodic vibration including the rotational frequency of the coupled shafts and its multiples. (2) Unbalance faults produce harmonic vibrations with a frequency equal to the rotational frequency of the unbalanced rotor. (3) Localized gear fault produces impact vibration repeated at the rotational frequency of the faulty gear.

(4) Localized fault in a ball bearing produces impact vibration repeated at the fault frequency of the faulty race (inner or outer).

Keywords: Fault diagnosis, Vibration, Misalignment fault, Unbalance fault, Gear fault, Ball bearing fault.

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