AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
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DIAGNOSIS OF COMMON MECHANICAL FAULTS IN ROTATING MACHINERY

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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.

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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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