INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : PRABHAT KUMAR

Roll Number : 166103028

Programme of Study : Ph.D.

Thesis Title: MODEL BASED ANALYSIS AND IDENTIFICATION OF UNBALANCE AND MISALIGNMENT IN ROTOR SYSTEMS LEVITATED BY ACTIVE MAGNETIC BEARINGS

Name of Thesis Supervisor(s) : PROF. RAJIV TIWARI

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SHORT ABSTRACT

The work presented in the thesis emphasizes mainly on the simultaneous identification of unbalance and misalignment faults as well as AMB stiffness parameters in a magnetically levitated rigid and flexible rotor system using a novel trial misalignment approach with model based identification algorithm. The proposed approach is aligned with the similar concept of trial unbalance in the rotor balancing. In real practice, the known trial misalignment between the rotor operating axis and AMBs axis can be provided by two innovative techniques i.e., physical trial misalignment (PTM) and virtual trial misalignment (VTM). At first, a rigid rotor with a disc at the middle levitated by two identical parallel misaligned AMBs is mathematically modelled. It is based on two translational displacements at AMB locations. The linearized form of force due to misaligned AMBs for the case of residual and additional trial misalignments has been obtained. The second model consists of both parallel and angular misalignments in a rigid rotor with two offset discs supported on two different isotropic AMBs. It is based on two translational and two rotational displacements at the rotor center of gravity. The third model is a FEM based model for a multidisc flexible rotor system equipped with multiple (anisotropic and different) misaligned AMBs. The last model is an extension of third model with integration of misaligned sensors along with misalignments in AMBs in a flexible rotor system. Moreover, the first three model is relying on PTM approach, whereas the last model is based on more reliable VTM approach. Equations of motion of the different models are developed and numerically solved to get time domain displacements at various rotor positions and controlling current responses at AMB locations. Further, a fast Fourier Transform (FFT) technique is utilized to obtain frequency domain responses from time domain signals. The magnitude and corrected phase of the responses are computed to get the real and imaginary components of frequency based signals. These are given as input in the novel trial misalignment based identification methodology for quantitative estimation of unknown unbalance and AMB misalignment parameters in a rotor-AMB system. The rotor unbalance parameters (disc eccentricities and phases), AMB residual misalignments and their force-displacement and force-current stiffness constants are the identified parameters from developed estimation methodology. Additionally, the residual offsets of sensors located at AMB locations are also identified using VTM approach in the final model. The identification algorithm has been tested against various levels of measurement noise and modelling errors and found to be robust.