INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **MODEL BASED IDENTIFICATION OF INTERNAL AND EXTERNAL DAMPING IN A CRACKED ROTOR**

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SHORT ABSTRACT

The aim of the work is to develop an identification algorithm to estimate various rotor faults present in a rotor bearing system. The methodology considered both external and internal damping where the external damping mainly occurs due to bearings and the internal (rotating) damping, which appears due to rubbing of free surfaces and material hysteresis during shaft rotation in dynamic conditions. Internal damping is also one of the causes of instability in rotors, when the rotor system rotates above critical speeds. Experimental estimation of the internal damping is a challenging task as compared to the external damping in a cracked rotor system. Hence, the main contribution of the present work is to distinctly estimate the internal and external damping in a cracked rotor-bearing system both theoretically and experimentally.

In the process of development of identification procedure in the form of regression equation for the estimation of internal and external damping other important unknown system parameters, like the unbalance and loss of stiffness of shaft due to the crack, are also identified. This reduces the estimation error of main parameters to be estimated. For this purpose, initially a simple two and four degrees-of-freedom (DOFs) rotor model has been considered, which includes two translational co-ordinates and two translational as well as rotational co-ordinates respectively. In four DOFs modeling, effect of the gyroscopic couple is also considered due to an offset disc. Here, to overcome the practical difficulty of measuring rotational DOFs accurately, the dynamic condensation has been carried out in the development of identification algorithm. In both the modeling of the rotor system, the crack model is based on the assumption of a switching crack, which gives excitation at multiple harmonics both in forward and backward whirl. Full spectrum responses are obtained through fast Fourier transform (FFT) of numerically generated displacement responses and are utilized in the developed identification procedure to estimate rotor system parameters, which is found to be robust even in the presence of measurement noise in system responses and bias errors in system parameters. For the application of the developed identification procedure in the physical system, experimentally measured are processed through the same methodology as done in the numerically generated signal. Residual bow in the shaft affects the 1X component of the frequency domain response (full spectrum), which is removed by utilizing slow run response of the rotor system. Moreover, ambiguity in phase while using FFT to get full spectrum is tackled by using multi-frequency reference signal. Estimates from experimental measurements are found to be consistent even at different rotor speeds.

Finally, to model a more realistic rotor system, the current work has been extended for cracked flexible-rotor flexible-bearing with multiple-disc rotor system using finite element modelling considering four-DOF per node. Herein, apart from internal damping, bearing stiffness and damping coefficients have also been estimated using the developed identification algorithm with the help of full spectrum. To check the robustness of the algorithm random noise is added to the time domain responses and estimate the fault parameters associated with the rotor system.