Title of PhD:	**Development of novel bore aerodynamic journal bearings for sustainable industrial technologies**
Student:	**Mr. Manas Ranjan Pattnayak (2018MEZ8286)**
Viva schedule:	**23rd August 2023 (Wednesday), Time: 11.30 am**
Venue:	**II-265 (Committee room)/II-422 (Seminar room) of DME**
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Abstract

The growing awareness related to the conservation of energy and environment has attracted the attention of the research community to develop and use the sustainable industrial technologies. Thus, there is need to develop and adopt energy-efficient and maintenance-free aerodynamic journal bearings (AJBs) as a replacement for conventional rolling-element and oil-lubricated journal bearings. Self-acting AJBs use air/gas as the lubricating medium, which is freely available in nature having eco-friendly and non-degradable properties. Presently, the AJBs are seen in micro-turbomachines (turbochargers of modern high-speed electric vehicles, turbopumps of space launch vehicles, environment control units of commercial and fighter aircrafts, biomedical centrifuges, printed circuit board (PCB) manufacturing instruments, food-processing and pharmaceutical devices) to support and guide relatively lightly-loaded and high-speed rotors, where hazardous chemical (lubricating oil/grease) cannot be used, and very frequent acceleration/retardation of the rotor is normal. However, these bearings experience two major problems: low load-carrying capacity (LCC) and instability concerns due to sub-synchronous self-excited fluid-induced vibrations. Focusing on these lacking issues, attempts have been made in this thesis to understand the tribological and dynamic behaviours of rotors supported on conventional AJBs and develop few novel AJB bores having improved tribodynamic performances as compared to conventional bores.

Hence, the objectives for this thesis set are as follows: (i) Compilation and discussions of published research articles on AJBs for the ready reference and to propose directions of further research; (ii) Tribological and dynamic performance investigations of a novel AJB bore comprising rigid and compliant bore segments together; (iii) Mathematical studies for enhancing the performances of AJBs by employing a micro-pocket and micro-textures on the bore; (iv) Performance improvement of self-acting journal bearings by synergistically employing a novel trapezoidal pocket and bio-inspired textures; (v) Dynamic performance of accelerating rotors supported on conventional rigid-bore AJBs; (vi) Design, development and fabrication of an air journal bearing test rig for experimentally studying and comparing the tribodynamic performances of rotors supported on new bore AJBs (as conceived in objective ii) to that of conventional rigid and conventional compliant bores.

Based on the numerical investigations performed with the new bore (NB) AJB (objective-ii), 5-260% increase in minimum film thickness and 80-175% improvement in stability parameters have been achieved for the range of operating parameters adopted in comparison to conventional bump-foil journal bearing. Similarly, substantial improvements in both static (up to 21% increase in minimum film thickness, up to 12% reduction in coefficient of friction) and dynamic performances (improved bearing dynamic coefficients and up to 170% rise in critical mass) have been found with the conceived new rigid AJB bores (objective-iii) compared to conventional cases. Again, mathematical research on the tribodynamic performance investigations of a new self-acting journal bearing (objective-iv) employing a bio inspired textures inside a novel trapezoidal pocket has shown significant enhancement in minimum film thickness (up to 70%), reduction in friction (up to 16%), substantial decrease in film temperature rise, and improvement in rotordynamics (critical mass more than 300%) in comparison to conventional plain bore. New mathematical research (objective-v) on the dynamic performance of accelerating rotors supported on AJBs has shown that during the acceleration phase, the acceleration should be scheduled in at least three regimes: the first with the maximum torque, the second with the minimum torque, and the last with an intermediate torque to limit the whirl amplitude and the associated frequency as low as possible. Experimental research (objective-vi) has shown that the vibration amplitudes achieved with the NB are found the lowest among all the cases. Moreover, the rotor orbit centres with the NB are found closest to the bearing centre indicating improvements in the dynamic stability and load- carrying capacity. The sub-synchronous and higher-order harmonic vibrations are found insignificant with the NB.

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