# ABSTRACT

The present work investigates the scope for the active vibration control of flexible rotor-shaft-bearing systems with the help of an electromagnetic actuator, different from an active magnetic bearing (AMB), as it is not used for the bearing action. The rotor-shaft system is supported by conventional bearings according to the design of the system and the actuator is placed on the stator at any suitable location along the span of the rotor-shaft, avoiding coincidence with the bearings and rotor-discs, to apply suitable force exclusively for the purpose of vibration control. Linearized force components provided by the actuator, in terms of displacement of the vibrating rotor-shaft at the actuator location and the control current in the actuator coils are used. The control current is determined after considering a proportional-plus-derivative control strategy applied to the displacement components of the rotor-shaft as sensed by the co-located sensors at the actuator location so that the control force can be considered as a combination of a restoring force and a damping force. Outcome of the numerical simulation has helped to establish the effectiveness of the proposed control scheme in order to mitigate the transverse vibration of the rotor-shaft system due to unbalance in the rotor mass and to postpone its stability limit speed (SLS) in the presence of internal damping of the shaft material. The actuator is also shown to be successful in controlling the transverse vibration of the flexible rotor-shaft, when it is mounted on a moving base as on ships and manoeuvring aircrafts, in which case, the equations of motions are, in general, time-varying and give rise to parametric excitations as well as excitations due to inertia force in addition to the usual external excitation due to mass-unbalance. The method of multiple scales is used in this case to identify the regions of instability under the parametric excitation. Usefulness of the actuator is tested next, to reduce the rotor vibration amplitude when the transverse and torsional modes of vibration of a flexurally as well as torsionally compliant rotor-shaft system are coupled dynamically, as in some non-stationary situations like speeding up or coasting down, sudden impact or sudden loss of mass (in the form of a blade or a portion thereof). For this case also the performance of the actuator was excellent in reducing the transverse vibration response and most importantly the torsional vibration response and enhancing the SLS. Finally an attempt is made to obtain a reduced analytical model of a rotor-shaft-bearing system by including a few selected co-ordinates, amenable to measurement and feedback. A modified scheme based on the System Equivalent Reduction Expansion Process (SEREP), involving both left and right eigenvectors, as the rotor-shaft system is generally a non-self-adjoint one, is proposed and found to closely predict the rotor response.

**Keywords**: Active vibration control, electromagnetic actuator, stability limit speed, base excitation, parametric instability, coupled transverse-torsional vibration, method of multiple scales, system equivalent reduction expansion process.