# Nidish Narayanaa Balaji *March 11, 1996*

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## Professional Experience

Department of Aerospace Engineering, IIT Madras — Chennai, India
**Assistant Professor** *2024 – present*
Assistant Professor in the Structural Dynamics area, with research focused on vibrations, nonlinear dynamics, and multi-scale contact modeling.

Institute of Aircraft Propulsion Systems (ILA), University of Stuttgart — Stuttgart, Germany
**Humboldt Postdoctoral Researcher** *2022 – 2024*
Member of the Institute of Aircraft Propulsion Systems group under Prof. Malte Krack, with experimental and theoretical research focusing on quasi-periodic stick-slip oscillations, stochastic dynamics, nonlinear modal analysis, etc. Research supported by a Humboldt postodoctoral grant.

Rice University — Houston, Texas, USA
**Postdoctoral Researcher in Mechanical Engineering** *2021 – 2022*
Member of the Tribomechadynamics Lab, with research focusing on video-based modal testing and system identification using DIC. Employed deep learning to determine potentials for its applicability in this domain.

## Education

Rice University — Houston, Texas, USA
**Ph.D. in Mechanical Engineering** *2017 – 2021*
Member of the Tribomechadynamics Lab, with research focusing on interface modeling & reduction for bolted structures, Multi-Objective Optimization & statistical modeling for parameter estimation, Nonlinear Modal Analysis, System Identification, High-Performance Computing, etc. Graduated with a GPA of 4.046/4.00. Thesis Title: *Dissipative Dynamics of Bolted Joints*

Rice University — Houston, Texas, USA
**Master's degree (M.S.) in Mechanical Engineering** *2017 – 2019*
Worked on predictive modeling of jointed systems. Developed a finite element modeling approach with multi-scale contact laws incorporating features from interfacial scan data. Graduated with a CGPA of 4.073/4.00. Thesis Title: *Multi-Scale Modeling in Bolted Interfaces*

Indian Institute of Space Science and Technology — Thiruvananthapuram, Kerala, India
**Bachelor degree (B.Tech.) in Aerospace Engineering** *2013 – 2017*
Started working on Nonlinear dynamics, frequency solution techniques, Hamiltonian chaos, periodic solutions, and journal bearings in rotor dynamics. Gained a considerable amount of experience in computational modeling for nonlinear dynamical systems. Graduated with a CGPA of 8.75/10.00

## Research Interests

**Non-exhaustive, and in alphabetical order** control-based continuation, control systems, experimental dynamics, friction in contacts and joints, multi-objective optimization, nonlinear finite element methods, nonlinear dynamics & chaos, nonlinear system identification, parameter identification, quasi-periodicity, reduced order modeling, structural dynamics and vibration, statistical estimation, uncertainty quantification, etc.

## Awards and Recognitions

1. Awarded the *Alexander von Humboldt Postdoctoral Fellowship* for conducting research at the University of Stuttgart, hosted by Prof. Malte Krack.
2. Awarded the *2020-2021 Emmett T. and Geraldyne Smith Roberts Award* by the Department of Mechanical Engineering, Rice University. The purpose of the award is to recognize a graduate student that has demonstrated academic achievement and outstanding quality of research.
3. Awarded the *Resiliency Award* from the AMPT Center, Rice University (Additive Manufacturing, Performance and Tribology center) during the 2020 AMPT Symposium for "demonstrating exceptional resilience in research in the face of challenges posed by COVID-19.".

4. Awarded the *Ken Kennedy-Cray Inc. Fellowship* for the academic year 2019/20 by the Ken Kennedy Institute, Rice University, for the development of High-Performance codes for Joint Dynamics.

## Skills

**Technical Expertise:** Programming Languages: C, C++, CUDA, Fortran, Julia, Lisp, Maxima, MATLAB, Python, Unix-shell, etc. • CAE Software: Abaqus, Calculix, Code_Aster, FreeCAD, OpenSCAD, etc. • Experimental Tools: LabView, Mathworks Dspace, Siemens TestLab. • GNU/Linux.

**Natural Languages** Tamil (*mother tongue*), English (*full professional proficiency*), Sanskrit (*average proficiency*), Hindi (*average proficiency*)

## Collaborative Projects

**The Loewner framework for nonlinear system identification** *Apr '22 — (current)*
Collaborators: Prof. Athanasios C. Antoulas (Rice, MPI-Magdeburg), Dr. Ion Victor Gosea (MPI-Magdeburg), and Prof. Matthew R. W. Brake (Rice)
Working on an interpolatory framework for state-space identification of nonlinear dynamics based on the Loewner-framework (originally developed for reduced order modeling). Employing a slow-fast time-scale splitting in order to identify data from a nonlinear system as a linear system parameterized by the response (slow time) amplitude. Results are being demonstrated on experimental data conducted in-house.

**A Wave-Based Modeling Approach for Jointed Systems** *Apr '21 — Jul '22*
Guides: Prof. Michael Leamy (GATech) and Prof. Matthew R. W. Brake (Rice)
Worked on a novel wave-based approach for non-linear dynamics modeling of jointed 1D structures using regular perturbation and plane wave expansion. Developed novel approaches for periodic solutions and stability.

**Two data-driven model-based techniques towards predicting frequency responses of nonlinear jointed structures** *May '19 — Dec '19*
Guides: Dr. Malte Krack (Stuttgart), Dr. Jean-Philippe Noël (Eindhoven) and Dr. Matthew R. W. Brake (Rice)
Participated in the summer institute Tribomechadynamics Research Camp (TRC 2019). We worked on the Polynomial Non-Linear State Space (PNLSS) and a Phase-Locked Loop (PLL) based identification technique and compared them for merits and demerits when applied to predict the frequency responses of nonlinear jointed structures.

**Gerrymandering for Boltled Joint Interface Reduction** *May '18 — Dec '18*
Guides: Dr. Matthew R. W. Brake and Dr. Malte Krack (Stuttgart)
Working with a visiting Master's student from the University of Stuttgart, who is writing his thesis at Rice. The work consists of choosing appropriate interfacial elements in order to efficiently represent the static stresses as well as the expected nonlinear solution. The reduction approach is formulated in a hyper-reduction framework, allowing one to evaluate the nonlinear forces in the reduced coordinates. This gave me a lot of insight into the linear algebra of unsymmetric matrices and it's associated Krylov projections. I helped develop the interfacial models and the solvers used for the project.

**Suitability of the Asymptotic Numerical Method for Frequency Solvers** *June '18 — Aug '18*
Guides: Dr. Malte Krack (Stuttgart) and Dr. Aurelien Grolet (ENSAM)
Participated in the summer institute Nonlinear Dynamics for Coupled Structures and Interfaces 2018 (NDCSI) held in Imperial College London, along with 17 other graduate students from across Europe and USA. The work involved bench-marking and comparing a classical continuation approach used for frequency solvers (AFT-PC) and a relatively recent method known as the Asymptotic Numerical Method (ANM). Using the guidance from the developers of two MATLAB packages for both, members of my group and myself (4 of us in total, from the University of Stuttgart, University of Kassel, and University of Lyon), developed a unified framework to compare the two approaches in terms of solution accuracy, computational effort, etc.

## Miscellaneous Interests

**Non-exhaustive, and in alphabetical order** Chess, Free and Open-Source Software (GNU movement), History, Indian classical music, Indian philosophy, Martial Arts, Vedic recitation & practice