Lateral Rotordynamics of Electrical Machines

Location: Aalto University, TUAS-Building, Maarintie 8.

Lecturers: Prof. Rainer Nordmann, Darmstadt University of Technology, Germany
Prof. Ulrich Werner, Technische Hochschule Nürnberg, Germany
Prof. Antero Arkkio, Aalto University, Finland
Docent Timo Holopainen, Aalto University/ABB Motors & Generators, Finland

Person in charge: Prof. Anouar Belahcen, Aalto University, Department of Electrical Engineering and Automation

Language: English

Enrolments: By email to: anouar.belahcen@aalto.fi (please fill in the form below)
The course fee is 200 €. For university students the course is free of charges.
The arrangements for the travel and accommodation must be carried out by the participants. Coffees and lunches will be served.

Schedule: The course will start on Mon. 10.9 at 9.00 and ends on Fri. 14.9 at 15.30.
During the week, the lectures and exercises are given every day from 9.00 to 15.30. Detailed schedule is at the end of this leaflet.

Topic: Electrical motors and generators comprise a large subset of rotating machines. High performance and reliability of these machines requires well-functioning rotordynamics. The lateral rotordynamics of electrical machines is influenced by unique features missing from other rotating machines. The rotors of electrical machines are constructed to guide the magnetic flux, electric currents, heat flow and cooling medium. In addition to these functions, the rotor design must fulfill the stiffness and other requirements demanded by the rotordynamics. Particularly, the magnetic fields interact with the rotor vibrations and the fabricated rotor structure is sensitive to temperature effects.

Pre requisites: Basics in Electrical or Mechanical Engineering

Assessment: Presence (30%), Exercises (30%), Assignment (40%). No exam. The students are required to attend min. 60% of lectures and 60% of Exercises/simulation sessions.

Objectives: The objective of the course is to introduce the lateral rotordynamics of electrical machines based on the two disciplines, i.e. mechanics and electromagnetics. The aim is that the students, after this course, a) have an overview of rotordynamics, b) are ready to carry out simple rotordynamic analyses, and c) are capable to review critically analysis reports circulated in industry.

Content:
1. Rotor models for lateral rotordynamics
2. Influence of bearings and gyroscopic effects
3. Magnetic forces and electromechanical interaction
4. Vibration measurement and balancing methods
5. Large induction motors and evaluation of vibration performance
6. Turbogenerators and power generation trains
The lecturers:

**Prof. Rainer Nordmann** was born 11. April 1943, studied Mechanical Engineering at TH Darmstadt and then undertook PhD research in Rotor Dynamics at the Machine Dynamics chair of TH Darmstadt. He was appointed Professor of Machine Dynamics at University of Kaiserslautern in 1980, teaching Machine Dynamics and Control and researching in Rotor Dynamics with applications to Turbomachinery. In 1996 he became Professor for Mechatronics in Mechanical Engineering at TU Darmstadt. His research activities at TU Darmstadt were concentrated on the development of Mechatronic Systems with applications to Rotating Machinery, Machine Tools and Automotive Systems. He was involved in several special domain research projects and supervised more than 100 PhD students. The methods and results of the research projects were published in several papers in International Journals and were presented at national and international conferences. Rainer Nordmann is coauthor of the two Springer books on Rotor Dynamics and Magnetic Bearings. He served as Dean of the Mechanical Engineering Department at TU Darmstadt from 2003 to 2005. During that time, he was member of the Senate of TU Darmstadt. After his retirement in 2009, Rainer Nordmann worked from 2009 to 2012 as manager for Rotor Dynamics in the international R&D Center of Alstom Power in Baden (Switzerland). From 2009 to 2016, he was Chairman of a ISO Working Group “Rotor Dynamics and Vibrations of Machines” and from 2006 to 2011, Chairman of the IFToMM Technical Committee Rotor Dynamics. Today he is consultant for the Fraunhofer Institute for Structural Durability and System Reliability LBF in the area of Adaptronics. He is involved in other consulting activities for different companies in the area of Rotor Dynamics and Mechatronics.

**Prof. Ulrich Werner** received 1994 the Dipl.-Ing. degree from the Friedrich-Alexander-University Erlangen Nuremberg (FAU) and 2006 the Dr.-Ing. degree from the University of Technology, Darmstadt, Germany. From 1994-2014 he worked for Siemens AG in Nuremberg, Germany, where he became 2008 the head of the motor simulation group. Since 2014 he is full Professor at the Georg-Simon-Ohm-University of Applied-Sciences in Nuremberg with focus on mechatronic systems and simulation/modeling. His area of expertise is rotordynamics of electrical machines.

**Prof. Antero Arkkio** was born in Vehkalahti, Finland in 1955. He received his M.Sc. (Tech.) and D.Sc. (Tech.) degrees from Helsinki University of Technology in 1980 and 1988. He was Laboratory manager of electrical machines, 1.8.1983–30.9.1995 and Senior Research Scientist, 1.10.1995–31.8.2001, in Helsinki University of Technology. Currently, he is a Professor of Electrical Engineering at Aalto University. His research interests deal with modelling, design, and measurement of electrical machines. Most of his research is related to numerical magnetic field analysis. He has authored or co-authored 160 journal papers and 235 conference papers. In 2013, Prof. Arkkio received the ERC Advanced Grant to study the “Additional losses in electrical machines”.

**Dr Timo Holopainen** was born in 1959. He received his M.Sc. (Tech.) degree in mechanical engineering and D.Sc. (Tech.) degree in electrical engineering from Helsinki University of Technology (now Aalto University), Finland, in 1987, and 2004, respectively. He worked for VTT Manufacturing Technology (1985-2003) focusing on strength and vibration issues of marine structures and rotating machines. Since 2004, he has worked for ABB Motors and Generators, Helsinki, Finland. Currently he is a Senior Principal Engineer and his interests deal with rotordynamics and vibration control of large electrical machines. In 2017, Aalto University granted him the Honorary Title of Docent in Mechanics of Electrical Machines. He is a member of the IFToMM Technical Committee for Rotordynamics and the API 684 Task Force (Rotordynamic Tutorial).

### Tentative schedule of the course:

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<tr>
<th>Monday 10.9</th>
<th>Tuesday 11.9</th>
<th>Wednesday 12.9</th>
<th>Thursday 13.9</th>
<th>Friday 14.9</th>
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<tr>
<td>9:00 - 10:30</td>
<td>Electrical machines</td>
<td>Simple rotordynamic models</td>
<td>Gyroscopic effects and induction motors</td>
<td>Vibration measurement and balancing methods</td>
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<td>10:30 - 11:00</td>
<td>Coffee break</td>
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<tr>
<td>11:00 - 12:30</td>
<td>Vibrations of electrical machines</td>
<td>Influence of bearings</td>
<td>Electromagnetic forces</td>
<td>Exercises</td>
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<td>12:30 - 13:30</td>
<td>Lunch</td>
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<td>13:30 - 15:30</td>
<td>Exercises</td>
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**Registration form (please copy and paste to the email body), then fill in the required information, email title: PhDcourse-registration**

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