TECHNISCHE UNIVERSITÄT DARMSTADT

Einladung zum Kolloquium

Elektrische Antriebssysteme

am Fachbereich Elektrotechnik und Informationstechnik

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Darmstadt, 01.07.2021

#	Zeit	Titel	Zoom-Link
1	07.07.2021 14:00	Electrical Machines in the Context of Interdisciplinary Research	Auf Nachfrage bei dekanat@etit.tu-darmstadt.de
2	08.07.2021 13:00	N.N.	Auf Nachfrage bei dekanat@etit.tu-darmstadt.de
3	09.07.2021 13:00	From e-motor to integrated e-drive systems – today's experience and vision of future NVH performance	Auf Nachfrage bei dekanat@etit.tu-darmstadt.de
4	12.07.2021 10:00	Electrical machines for xEV main drive – overview and challenges	Auf Nachfrage bei dekanat@etit.tu-darmstadt.de
5	13.07.2021 9:00	A generic framework to minimize copper and iron losses in electrical machines in real time	Auf Nachfrage bei dekanat@etit.tu-darmstadt.de
6	14.07.2021 10:30	Efficient Modeling of Magnetic Materials - The Key to Energy Efficient Electrical Drives	Auf Nachfrage bei dekanat@etit.tu-darmstadt.de

Ablauf aller Vorträge

a) **20-minütiger hochschulöffentlicher Lehrvortrag** in deutscher Sprache mit dem fest vorgegebenen Thema „Erzeugung eines rotierenden magnetischen Feldes“ mit anschließender **10-minütiger Fragerunde**.

b) **40-minütiger hochschulöffentlicher wissenschaftlicher Vortrag** in englischer Sprache eines *wissenschaftlichen Themas* mit thematischem Bezug zur ausgeschriebenen Stelle sowie **anschließender Aussprache zum Vortrag.**

Vorstellung der Themen

1) Electrical Machines in the Context of Interdisciplinary Research

Abstract:

Rapid technological changes pose new challenges for electrical machines. These devices must perform much more sophisticated tasks with higher efficiency, dynamics and power density. Also the converter-fed operation of electrical machines will potentially bring new challenges in term of losses, insulation deterioration and bearing currents. Both the new application areas and the strict boundary conditions are forcing a broader approach to the design, modeling and optimization of electrical machines. The application of new materials, additive manufacturing of electrical machines, sophisticated loss calculation methods, complex predictive maintenance algorithms, motor-inverter interactions such as bearing currents and insulation stress, etc. require a multi-domain approach and interdisciplinary collaboration. How can an interdisciplinary approach to modeling, measurement, calculation and design of electrical machines lead to a convincing result? The lecture will answer this question based on some recent projects and explores new opportunities for interdisciplinary collaborations in the field of electrical machines. These include topics such as bearing current measurement, additive manufacturing, insulation stress and iron losses.

3) From e-motor to integrated e-drive systems - today's experience and vision of future NVH performance

Abstract:

In the presentation, the relevance of noise, vibration and harshness (NVH) for electric motors for e-mobility will be in focus. Based on the changes in the e-mobility market towards an increasing demand for integrated e-axles with a specific set of requirements, the resulting new demands for e-motors will be analyzed, especially for NVH. Starting from the requirements and influence factors, root causes for noise and vibration will be explained in detail and a proceeding for their structured assessment will be presented. In this context, capabilities and limitations of CAE simulations for NVH behavior prediction are discussed. Based on the main influence factors, todays measures and future approaches to improve the e-motor NVH behavior is shown.

Finally, an engineering workflow including CAE based optimization to realize e-motors fostering powerful, efficient and quiet e-axles is explained.

4) Electrical machines for xEV main drive – overview and challenges

Abstract:

Electric motors (EM) for cars have been used since the 1830s, even before the internal combustion engine (ICE) came up. As such, nearly all types of EM have been used for traction applications, but it seems that there is still no definite answer as to what type of EM is finally the best suited. After a brief historical introduction to the use of EM as main traction drive for electric vehicles (EV), the presentation will compare the most widely used types of EM with their advantages and disadvantages.

As many applications focus on the Inner Permanent Magnet Synchronous Motor (IPMSM), the presentation will use this type to go deeper into detail, concentrating in the following on the constraints and challenges that the design and manufacturing of these types of EM encounter, giving an overview of main and parasitic effects to be taken into consideration, like mechanical stress, demagnetization as well as noise and vibration, bearing currents, manufacturability, etc.

Finally, new trends and technologies for the electric drive system and their impact to the EM will be summarized.

5) A generic framework to minimize copper and iron losses in electrical machines in real time

Abstract:

Electrical machines consume more than 50% of the globally generated electricity. Hence, several online loss minimization methods for electrical machines have been proposed; in particular for synchronous machines (SMs) with non-negligible saliency and machine nonlinearities. The online computation of the optimal reference currents for the different operation strategies such as Maximum Torque per Current (MTPC), Field Weakening (FW), Maximum Current (MC) and Maximum Torque per Voltage (MTPV) or Maximum Torque per Flux (MTPF), is usually done numerically or analytically imposing several simplifying assumptions (e.g. neglecting stator resistance and/or cross-coupling inductance and/or iron losses) on the machine model or the physical constraints (e.g. voltage ellipse).

Numerical solutions, in general, increase the computational load on the real-time system. Analytical solutions are more attractive, since they are easier to implement, more accurate, faster to compute and make large look-up tables (LUTs) with more than two or three dimensions obsolete. However, to the best knowledge of the speaker, a generic framework providing analytical solutions while explicitly considering copper and iron losses and arbitrary machine nonlinearities for all operation modes is not yet available. In this talk, a generic loss minimization method for optimal feedforward torque control (OFTC) of electrical machines is presented which allows to analytically compute (i) the optimal direct and quadrature reference currents for all operating strategies, such as MTPC, MC, FW, MTPV or MTPF, and, in particular, Maximum Torque per Losses (MTPL, which considers copper & iron losses) (ii) the transition points indicating when to switch between the operating strategies due to speed, voltage and/or current constraints. The analytical solutions allow for an instantaneous selection of the actual operation strategy and the computation of its corresponding optimal reference currents.

6) Efficient Modeling of Magnetic Materials - The Key to Energy Efficient Electrical Drives

Abstract:

The development and electromagnetic design of energy efficient electrical drives requires accurate knowledge of the magnetic material behavior, i.e., iron loss components and magnetizability, already in the design stage, in order to allow predictions of the operational characteristics along the torque–speed map. This is exacerbated, for example, by the elevated operating frequencies, the inverter supply, the increased material utilization and the strong influence of the manufacturing and production process. This presentation will give an overview of advanced and efficient modeling approaches for magnetic materials in the computer-aided design of rotating electrical machines covering different parasitic effects and the strong influence of manufacturing-related mechanical stress. This is topped off with application examples.