Dr. Mohammad Islam received the BSc and the MSc degrees from Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh, and the PhD degree from the University of Akron, Ohio, USA, all in electrical engineering, in 1994, 1996 and 2001, respectively. Currently, he is a Chief Scientist at HL Mechatronics in Bay City, Michigan where he manages design and development of electric motors, magnetic sensors and actuators and EMC/EMI related activities for automotive applications. From 1994 to 1996, he was with the electrical and electronic engineering department of BUET as a lecturer. From 2001 to 2013 he worked for Delphi Steering and Nexteer Automotive in Saginaw, Michigan as a staff research engineer at the R&D Center.

Dr. Islam is widely known in the automotive industry for the development of permanent magnet synchronous motors, innovative low-cost sensors and actuators, particularly torque sensors, position sensors, steering/braking actuators with permanent-magnet (PM) brushless motors. Since their inception, the motors and sensors have been produced in tens of millions by many automotive OEMs worldwide. As a recognition of his contributions to the technical community and real world applications, Dr. Islam was elevated to IEEE Fellow class 2016 with the citation "*for development of electromagnetic sensors and actuators for automotive applications*". As more and more electrifications happening in transportation sectors, he continued to develop electric motors and sensors for redundant safety critical architectures for automotive applications. In 2019, Dr. Islam was named one of the recipients of the prestigious Nagamori award with the citation "*Contributions to electric motors and electromagnetic actuators and sensors for safety critical automotive applications*".

Dr. Islam served as the chair of the transportation systems committee of IPCSD-IAS. He served in IAS executive board as the Chair of awards department from 2013-2016. He also served as vice chair and chair in IAS fellow review committee during 2017-2018 and 2019-2020, respectively. He also served in the IEEE fellow review committee in 2021. He also served as the technical program chair of ECCE 2022. Dr. Islam has published 24 journal and over 46 conference papers and currently holds 36 US patents with several more pending. His research interests include electric machines, adjustable speed drives and EMC for automotive applications.

List of lecture topics with the titles and short abstracts

Topic #1:

Electric Machines for Redundant Safety Critical Applications

Abstract — Redundant machine configuration is getting more attention for high performance safety critical applications such as autonomous driving, electric vehicle etc. Permanent magnet (PM) synchronous motors using dual/triple/quad 3-phase winding configurations is a viable candidate for such high performance applications due to high torque density, low torque ripple and low acoustic noise. Due to the presence of permanent magnet (PM) excitation, the machine behavior must be understood during normal and faulty conditions. For safety critical applications, the drive unit preferred to be fault tolerant and should have back-up capabilities at least for limp-home mode. For high volume cost and package sensitive applications, it is preferred to use one single machine in a redundant configuration to avoid additional cost and space. The slot/pole along with winding configurations play a vital role in configuring such machines in either in dual or multiple 3-phase configurations to achieve various levels of fault-tolerant capabilities. For a dual wound 3-phase machine, depending on the drive architecture, it could be configured to deliver either half or full load. The talk will cover useful guidance in selecting any particular winding type depending on the slot/pole combination along with performances and application requirements.

Topic #2:

Motor Design Considerations for Applications Requiring Low Torque Ripple and Low NVH for Mass Production

Abstract — This presentation is focused on various machine design considerations that can be used to reduce the torque ripple and improve the NVH performance of a sinusoidally excited permanent-magnet brushless dc motor. The talk will cover various sources of torque ripple and appropriate design techniques to consider at the early design stage. This will also cover the mechanics of vibration in permanent magnet (PM) synchronous motors due to electromagnetic (EM) origins. Several fractional slot PM topologies will be discussed to quantify the vibration phenomenon that is influenced by motor slot/pole and winding configurations. Multiobjective and multiload point design optimization for SPM/IPM using a global response surface method to achieve low torque ripple with high average torque over the entire speed range will be presented. This will also discuss how to obtain motor parameters under different load conditions to predict the torque/speed performance of the motors accurately. Additionally, the effect of build variations for mass produced permanent magnet synchronous motors on key performances such as torque ripple, back-emf harmonics and torque/speed will be discussed. The guidance for worst case scenarios hence provide tolerance limits for each of the design dimensions/parameters to be controlled to achieve desired performances in mass production.

Topic #3:

Rare-earth Free PMSMs for High Performance Applications – Challenges and Opportunities

Abstract — Electric motors for high performance applications require stringent performance goals. Besides smooth torque and low acoustic noise requirements, the motor should exhibit lower braking torque under shorted windings and inverter FETs. The conventional rare-earth (RE) based permanent magnet (PM) motors both surface-mount and interior-mount types offer high torque density and better packaging but lacks of fault tolerant capability due to the presence of strong RE magnets. The high cost and volatile supply chain of RE magnets inspired researchers to seek rare-earth free electric machines. However, due to the absence of RE magnets, the synchronous reluctance motors typically have lower torque density, lower power factor, and tend to exhibit higher torque ripple but exhibits better fault tolerant capability. In this presentation, a Ferrite based PMa-SynRel motor is designed to improve the torque density, power factor, and provides lower braking torque by avoiding RE magnets and is compared to a sintered NdFeB based IPM design to satisfy similar torque/speed requirements. Multi-load point optimization is adopted to ensure low torque ripple and high torque density in the entire operating range. Moreover, the risk of demagnetization of Ferrite based PMa-SynRel under extreme cold (-40 ◦C) is presented and compared with equivalent RE magnet based IPM design at hot temperature. The rare-earth material free machine design is more appealing for high performance applications requiring very low torque ripple including cogging torque and low braking torque under faulted conditions.

Topic #4:

Non-contact Sensing in Automotive Applications – a perspective of robustness and reliability

Abstract — This presentation will talk about sensor technologies used in high performance automotive applications. An example application considering motor shaft position, steering input torque and column position sensing will be discussed. Various topologies will be discussed in terms of advantages and disadvantages. Potential sources of errors due to electromagnetic origins and mechanical stacks and their impact on the overall system will be discussed.