Iqbal Husain (S '89, M '89, SM '99, F'09) is currently a Professor of ECE at The University of Akron, Akron, Ohio. From Fall 2011, he will be joining the ECE department of North Carolina State University as a Distinguished Professor. He received the B.Sc. degree from Bangladesh University of Engineering and Technology, Bangladesh, and the M.S. and Ph.D. degrees from Texas A&M University, College Station, Texas, in 1987, 1989 and 1993, respectively. All the degrees are in Electrical Engineering.

Prof. Husain worked as a summer researcher for Wright Patterson AFB Laboratories in 1996 and 1997. Previously, he taught as a Lecturer at the Texas A&M University and also worked for Delco Chassis at Dayton, Ohio as a consulting engineer. He has completed research works and consulted for several automotive and motor drives industries, such as, Delphi Chassis, Delphi Saginaw Steering Division, Nexteer Automotive, General Motors, Infineon Technologies, TRW, ITT Automotive, Goodyear Tire and Rubber, and Caterpillar.

Prof. Husain's research interests are in the areas of control and modeling of electrical drives, design of electric machines, development of power conditioning circuits, microinverters for distributed power generation, inverter controls for grid synchronization, and modeling of electric and hybrid vehicle systems. He has worked extensively on the development of SR and PM motor drives for various automotive and industrial applications. Prof. Husain has developed several sensorless control methods for switched reluctance machine (SRM) drives. He is the pioneer in developing and demonstrating a sensorless SRM drive with four-quadrant operation over a wide speed range and zero speed position hold capability. The pioneering research on modeling and analysis of SRMs allowed Prof. Husain to make unique contributions in SRM design, control, acoustic noise prediction, and parameter identification methods. The uniqueness of the SRM modeling and analysis approach is the dependence of the model on machine geometry and material property. Prof. Husain's SRM analysis and models have also provided the engineering community with the conclusive determination of the nature of unbalanced forces in SRMs. Due to the nature of the issue, there was considerable controversy regarding these unbalanced forces in the mid-1990s. The specific program Prof. Husain was involved with at the time, an aerospace SRM starter/generator for the Air Force, was facing a major obstacle. Prof. Husain developed analytical methods to calculate the unbalanced forces. The results clearly showed the possible effects of the forces on the system. Significant expenses were saved by not pursuing alternative technologies. The Air Force eventually completed the F-16 flight test program successfully using the switched reluctance starter/generators.

The primary application of Prof. Husain's work is in the transportation, automotive, and aerospace industries. As a result of this exposure, Prof. Husain naturally developed a strong electric and hybrid vehicles program at The University of Akron. The program includes courses for graduate and undergraduate education, research on electric drives for electric and hybrid vehicles, and participation in collegiate level competitions on alternative vehicles. The electric and hybrid vehicles course, first offered at Akron in 1996, is now taught at several Universities in North America as well as in Europe. As a result of this course development, Prof. Husain wrote the book *Electric and Hybrid Vehicles: Design Fundamentals*, which is the only textbook available on the subject and is now available in its second edition. Prof. Husain was the lead faculty advisor for the DoE and GM sponsored *Challenge X: Crossover to Sustainable Mobility* competition. The University of Akron was selected through a competitive process in 2004 as one of 17 university teams in North America to participate in this competition. The three-year, student engineering competition with tiered goals for each year called for the teams to re-engineer a 2005 Chevrolet Equinox crossover vehicle into an alternative vehicle to reduce energy consumption sharply and decrease the emissions of pollutants while maintaining its performance. In the design phase of the competition in 2005, the University of Akron was placed 2nd overall. The implemented hybrid vehicle completed a 230 mile road rally between New York and Washington DC in 2008.

Prof. Husain is the past chairman of the IEEE-IAS Electric Machines Committee, the current Technical Program Committee Co-Chair of the Energy Conversion Congress & Expo (ECCE), and a member of the Steering Committee for the IEEE-PEV conference. Prof. Husain received the 2006 SAE Vincent Bendix Automotive Electronics Engineering Award, the 2004 College of Engineering Outstanding Researcher Award, the 2000 IEEE Third Millennium Medal, the 1998 IEEE-IAS Outstanding Young Member award, and several IEEE-IAS prize paper awards. He was elected to be an IEEE Fellow in 2009.

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Lecture Topics

1. Electric Motor Drives and Power Electronics for Electric/Hybrid Vehicles and Renewable Energy Systems

- Electric and hybrid vehicle types and architectures
- Electric machines and drives for electric/hybrid vehicles
- Power electronics in electric/hybrid vehicles
- Power electronics in renewable energy systems

Environmental concerns and energy challenges have prompted all around efforts to develop clean, efficient and sustainable technologies for alternative transportation and renewable energy systems. The core technologies in these systems include power electronics, electric machines, controllers and energy storage. The electric machine is an integral component in the electric power transmission path of an electric or hybrid vehicle that operates either in the motoring mode or in the generating mode to process the power flow between the energy store and the wheels. The interior permanent magnet (IPM) machine is the choice of electric machine for the production hybrids, although vehicles are being produced and/or developed with induction and switched reluctance (SR) machines. Researchers are also evaluating alternative high power and high torque density machines, such as the axial flux and the transverse flux machines. The electric machine is also an integral component for wind and wave renewable energy systems. Electric machine based drives are also gradually replacing mechanical actuators in conventional automotive and aerospace applications. The elements in the electric motor drive system are the electric machine, the power electronic inverter, and the microcontroller/DSP based controller. The power semiconductor devices and the high-performance digital signal processors (DSP) are the essential enabling technologies for the motor drive system. The controller algorithm is designed and implemented in a DSP to provide the desired response characteristics, and to track the control command accurately. The motor drive system components are designed synergistically to deliver high efficiency, performance and reliability. This talk presents the trends and research on electric machines, motor controls, energy storage and power electronics for electric/hybrid vehicles and renewable energy systems.

2. Electric Motor Drives and Power Electronics for More Electric Transportation

- Actuators and electromechanical systems in vehicles
- Motor driven electromechanical brake systems
- Motors and controls for electric power steering
- Motor drives for Air-conditioning units
- Electric machines and drives for electric/hybrid vehicles
- Starter/generators for conventional and electric/hybrid vehicles

The power electronics and motor controls research in automotive electric drives are focused on low-cost and rugged drive systems using induction, permanent magnet or switched reluctance machines for various applications. This talk presents the trends and research on electric machines, motor controls and power electronics for more electric transportation systems and components.

Mechanical and electro-mechanical systems are used extensively in automobiles, in the alternator, starter, heating and air conditioning system (HVAC), anti-lock braking system, power steering and accessories, including windows and door locks. The shortcomings of electro-mechanical systems can be mitigated by replacing as much of the mechanics as possible with electronics. Moreso, electronics also allow for advanced functionality not possible using mechanics. Recent advances in power electronics and motor drives systems have facilitated a migration away from traditional electro-mechanical systems towards systems with a higher degree of electronics; for example, many hydraulic systems for automotive and aerospace applications are being replaced with motor-driven actuators. Momentum in the development of power electronics and motor drives is growing and will continue to grow in the future leading to vast reductions in the weight, size, and cost of motor drive systems.

The electric machines and drives are also the distinguishing components in the electric/hybrid vehicles, where they process the propulsion power for traction. While different in size and rating from the electromechanical actuators used in conventional vehicles, the machine and controller choices available are essentially the same.