Electric Vehicles (HEVs) and Electric Vehicles (EVs) are crucial technologies for the automotive industry to meet society’s demands for cleaner, more energy efficient transportation. Meeting the need to provide power which sustains HEVs and EVs is an immediate area of concern that research and development within the automotive community must address.

In the dissertation, battery, interior permanent motor (IPM) and the system level HEV drive system will be studied in multi-physics perspective using a combination of circuit analysis, electromagnetic Finite Element Analysis (FEA), and Computational Fluid Dynamic (CFD) finite volume method in the analysis.

Firstly, a novel electric-thermal battery modeling technique by coupling battery electrical circuit model and CFD physics based model is proposed. The model provides electrical heat generation as well as the temperature distribution considering the physical dimensions, material properties, and cooling conditions. The model is suitable for hybrid electric vehicle (HEV) and electric vehicle (EV) battery thermal management design.

Secondly, IPM electric machines are very important in high performance drive systems. During normal operations, irreversible demagnetization can occur due to temperature rise and various loading conditions. We investigate the performance of an IPM using 3D time domain electromagnetic FEA considering magnet's temperature dependency. Torque, flux linkage, induced voltage, inductance and saliency of the IPM will be studied in details. Finally, we use 3D time domain CFD to predict the non-uniform temperature distribution of the IPM machine and the impact on the electrical and mechanical performance of the motor due the temperature distribution.

Finally, we will switch gear to investigate the IPM motor on system level. FEA model is high fidelity model, it is suitable for machine designer to use. However, for system level simulation where many other components are present, even though FEA simulation is still possible, but the simulation speed is not ideal. A lumped element motor of the IPM motor whose parameters are based on FEA is proposed to consider the demagnetization due to temperature effect for a system level simulation. The impact of the motor to the entire system will be studied.

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The public is welcome to attend.