FUNDAMENTALS OF INDUCTIVE POWER TRANSFER

Currently, there is a strong drive to electrify the transportation sector as a solution to the environmental and economic impacts of vehicles using internal combustion engines. However, to-date, limitations of battery technologies have hindered the uptake of electric vehicles (EVs). For example, the main drawbacks commonly associated with EVs are the limited range and long charging times, both of which are a direct result of the low energy and power densities of current battery technologies. These issues are further aggravated due to the fact that the EVs need to be plugged-in to refuel, as it can take many hours to fully-charge a depleted EV battery. Although, fast and extreme fast charging systems have been developed and deployed to help EV users refuel in a fraction of an hour, this is achieved at the expense of battery life and user safety. In contrast, wireless charging of stationary and in-motion electric vehicles promises a future where EVs are replenished organically, thus avoiding long charging times, range anxiety and battery degradation. An ubiquitous wireless charging infrastructure, especially one that is bi-directional, can be used to provide grid services, thus not only drastically improving the uptake of EVs, but also supporting grids with high penetration of renewable electricity. WPT can also be used as a power delivery method in other applications, particularly in dirty or dangerous environments, e.g. industrial, medical and supply chain, space, light transport etc. In some of these applications light weight is extremely important. Multi MHz approaches can be useful in achieving low weight, and basic magnetics and circuit design for MHz IPT will also be discussed.

The school will start with a brief discussion on the history of wireless power transfer (WPT) technology. Subsequently, the fundamental operating principles of an inductive power transfer (IPT) system will be presented. Commonly used compensation networks, power electronics converters and magnetic designs will be then reviewed. This will be followed by a discussion on a few applications of IPT technology, with a special focus on wireless electric vehicle (EV) charging. A summary of developments to-date on both stationary and dynamic EV charging will be presented. To conclude the presentation, we will work through a few design examples and validate these designs using LTspice and Ansys Maxwell simulation models.

After completing this theory session, the participants can continue to work on an IPT project to further their understanding. Details about the project and a step-by-step guide is provided and can be accessed via this LINK. To follow this example project, participants can download free software copies - LTspice and Ansys Electronics Desktop Student. During the 2nd day of the school, the speakers will be available to help with questions relating to the project.

Speaker's Bio:

Duleepa J. Thrimawithana (M'06-SM'18), received his BE in Electrical Engineering (with First Class Honors) in 2005 and his Ph.D. in power electronics in 2009 from The University of Auckland, Auckland, New Zealand. From 2005 to 2008, he worked in collaboration with Tru-Test Ltd. in Auckland as a Research Engineer in the areas of power converters and high-voltage pulse generator design. He joined the Department of Electrical and Computer Engineering at The University of Auckland in 2009 where he currently works as a Senior Lecturer. He has co-authored over 100 international journal and conference publications and holds 24 patent families on wireless power transfer technologies. In recognition of his outstanding contributions to engineering as an early carrier researcher, Dr. Thrimawithana received the Jim and Hazel D. Lord Fellowship in 2014. His main research areas include wireless power transfer, power electronics and renewable energy.

Grant A. Covic (S'88-M'89-SM'04), is a full professor with the Electrical, Computer, and Software Engineering Department at The University of Auckland (UoA). He began working on inductive power transfer in the mid 90's, and by early 2000's was jointly leading a team focused on AGV and EV charging solutions. He has published more than 200 international refereed papers in this field, worked with over 30 PhDs and filed over 40 patent families, all of which are licensed to various global companies in specialised application fields. Together with Prof. John Boys he co-foundered HaloIPT and was awarded the NZ Prime Minister's Science Prize, amongst others for successful scientific and commercialization of this research. He is a fellow of both Engineering New Zealand, and the Royal Society of New Zealand. Presently he heads inductive power research at the UoA, is directing a government funded research program on stationary and dynamic wireless charging of EVs within the road, while also co-leading the interoperability sub-team within the SAE J2954 wireless charging standard for EV

Paul D. Mitcheson (Senior Member, IEEE) received the M.Eng. degree in Electrical and Electronic Engineering and the Ph.D. degree in Micropower Motion Based Energy Harvesting for Wireless Sensor Networks from Imperial College London, London, U.K., in 2001 and 2005, respectively. He is currently a Professor in Electrical Energy Conversion with the Control and Power Research Group, Electrical and Electronic Engineering Department, Imperial College London. His research interests include energy harvesting, power electronics, and wireless power transfer to provide power to applications in circumstances where batteries and cables are not suitable. His research has been supported by the European Commission, Engineering and Physical Sciences Research Council, and several companies. Prof. Mitcheson is a fellow of the Higher Education Academy and is on the Executive Committee of the U.K. Power Electronics Centre. He was the General Co-Chair of IEEE Wireless Power Week in 2019 in London, U.K. and is chair of IEEE PELS TC-9, Wireless Power.