Dr. G. T. Heydt

Two interesting mathematical methods: the Hilbert transform and the Hartley transform, and their applications in electric power engineering

Abstract

Two mathematical analysis techniques will be described for AC electric power systems: the Hilbert transform, and the Hartley transform. For both of these diverse methods, the transforms, their properties, and historical development will be presented. Competing alternative analytical methods shall be discussed and applications in specific areas of electric power engineering shall be given.

The Hilbert transform gives a unique way to calculate interarea dynamic modes, thus evaluating how the rotors of generating units ‘swing’ versus each other, and how their dynamics are damped – or not damped. The applications of the Hilbert transform in power engineering are in dynamic security assessment, power system stability evaluation, and power system stabilizer design. A calculation procedure known as the Hilbert-Huang transform has evolved from the traditional transform formulation – and this is suitable for large system and large data applications common in operational, interconnected power systems.

The Hartley transform is an all real variation of the Fourier transform, and the familiar properties relating to convolution and conversion of a linear differential equation to an algebraic equation lead to solutions of AC circuit problems. The Hartley transform has been modernized and popularized relatively recently in a form known as the Hartley-Bracewell transform. The Hartley-Bracewell transform includes a fast discrete formulation with excellent high speed calculation properties. The Hartley transform applications are in electric power quality engineering and general AC circuit analysis.

Both the Hartley and Hilbert transforms are rather unfamiliar to electrical engineers in general and electric power engineers in particular: the seminar has an objective of alleviating some of this unfamiliarity. The technology and evolution of these fields shall be discussed. Both transforms have some possibilities in an educational program in AC circuits and electric power engineering.
Biography of the Speaker

G. T. Heydt received the BEEE degree from the Cooper Union in New York, and the MSEE and PhD. from Purdue in West Lafayette, Indiana. He spent several years in industry principally with the Commonwealth Edison Co. in Chicago, and E. G. & G. at the Nevada Test Site in Mercury, Nevada. He has experience also in developing countries with the United Nations Development Program in Central America and the Pacific region. His UNDP work has been in electric power delivery.

Dr. Heydt is a Regents’ Professor and a Professor of Advanced Technology at Arizona State University in Tempe, Arizona. He is also a site director for the Power Systems Engineering Research Center (PSerc) and the Future Renewable Electric Energy Delivery Management (FREEDM) center. Both are NSF and industry supported engineering centers. Dr. Heydt is a member of the National Academy of Engineering and a Life Fellow of the IEEE. In June 2010, he was awarded the Harold Kaufmann award for excellence in distribution engineering.