# Foreword

In an age where many items have become throw-away, the care of long life assets such as transformers requires a different way of thinking. To determine the status of such key items of plant we need detailed models of how they behave under steady state and transient. The chapters here present first models to describe how the application of voltage transients translates to voltage stresses across insulation. The potentially damaging transients can be from lightning strikes, switching surges, or resonance with nearby equipment. As discussed here, there are some frequencies where the winding acts as a transmission line and for higher frequencies as a capacitive divider.

This range of different responses means that different models of windings are needed for different analyses. Rotating machine windings share many of the characteristics of transformer windings, but as discussed, there are different frequencies for which the different models apply.

Knowing the methods to analyse the electrical dynamics of a winding leads to the analysis of the operation of transformers in the system. The modelling of the transformer winding is very relevant to the correct design of lightning protection of substations.

Knowledge of the nature of the transients and the stress across the insulation is very relevant to designing of where to reinforce the insulation in a transformer. This analysis proceeds from the basic distribution of stresses across an ideal winding but progresses to the stresses on leads. In an age where there is much emphasis on reducing material, knowing the stresses is a critical part of determining the best allocation of effort in insulation.

Another key aspect of this detailed knowledge of winding transients is in the area of fault detection. Partial discharge deep within a winding can deteriorate to the level of a major fault. The chapters here show how the location of these incipient faults can be determined and a more enlightened decision of the opportunities for corrective action, and quantifying the winding damage can be determined.

These chapters of guidance are the result of many years of experience and refining of models of windings and the properties of partial discharge. The book editor, Charles Su, brings together these different contributions with over 35 years experience to his name in this area of power engineering. The team of contributors provide a wealth of detailed knowledge distilled from many years in the field and should prove valuable to those vested with the asset management of the key power system assets of transformers and large rotating machines.

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**Gerard Ledwich** *is the Chair in Power Engineering at QUT and is recognised as an industry leader in the field of power systems control. He has partnered with major industry power utilities in both research and industry initiatives during his 30 year career and made major conceptual advances in power system control. His particular expertise is in the fields of power system controls, adaptive controllers, dynamics, asset management, power distribution reliability, and distributed generation. Gerard has published one book, 101 journal papers, and over 192 refereed conference papers, and is the editor of two international journals (*IEEE Transactions on Generation, Transmission and Distribution *and the* International Journal of Emerging Electric Power Systems*). He has received $1.2 million in industry support for his Asset Management Chair at QUT and he has received more than $6 million for his research projects in recent years from the ARC and supply industry.*