Experimental set-up to explore effects of complex flux density waveforms in magnetic cores

SUMMARY
The goal of the project is to accurately measure and validate losses in magnetic cores used in Power Electronic converters.

PROBLEM DEFINITION
Magnetics play a major role in all Power Electronic converters, and calculating the losses of these components has historically been challenging [1]. Recently, Princeton university has created a large database called MagNet [2] that contains measured core losses under different excitation parameters (magnetic flux density *B(T)*, operating frequency *f(Hz)*, temperature *T*, and most importantly; waveshape).

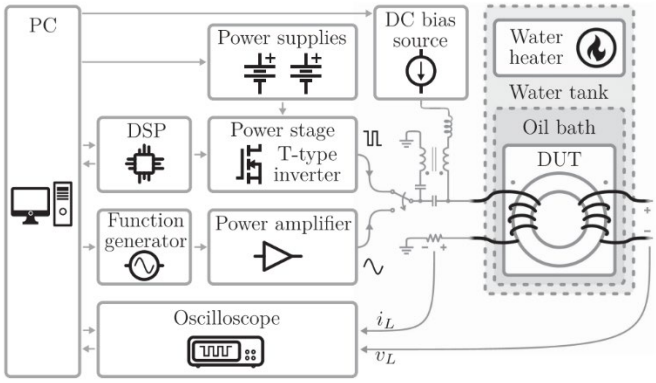

Figure 1: Example of an automated core loss measurement setup [3].

With the push for high-frequency operation of Power Electronics and the use of wide band-gap (WBG) devices, the need for better characterization of magnetic losses is higher since a lot of phenomenon which were unaccounted are beginning to show up. This project will involve the development of an (automated) core loss testing setup and the use of the setup for Power Electronics research!

METHOD
A literature review on core-loss measurement methods specifically to study complex flux density waveforms and implications of WBG devices. Based on the review and analysis, a topology/setup is chosen and must be designed and validated at the laboratory in UT.

RESEARCH OBJECTIVES
- Comprehensive overview of core-loss measurement techniques.
- Based on literature review, design of a set-up to measure core-losses
- Implementation of the set-up and validation of datasets.
- Use of developed setup for exploration of effect of complex B waveforms on core loss

COURSES
- 1A: Power Electronic Converters (compulsory)
- 1B: Electrical Machines and Drives (recommended)

[1] C. R. Sullivan, “Survey of Core Loss Test Methods” [Online], 2017, Available: https://bpb-us-e1.wpmucdn.com/sites.dartmouth.edu/dist/c/87/files/2017/03/Survey-of-Core-Loss-Test-Methods-Sullivan.pdf

[2] M. Chen et al, “MagNet Database for Sharing and Visualization” [Online], 2023, Available: https://mag-net.princeton.edu

[3] D. Serrano et al., "Why MagNet: Quantifying the Complexity of Modeling Power Magnetic Material Characteristics," in IEEE Transactions on Power Electronics, vol. 38, no. 11, pp. 14292-14316, Nov. 2023, doi: 10.1109/TPEL.2023.3291084.

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