中央大學物理學系

Department of Physics, National Central University



Colloquium

Date: 2026/11/24 (Tue)

Venue: S4-625

Time: 14:00-15:00

交通安全演講:肇事重建與當事人權益

張文菘教授

中央警察大學

Time: 15:15-16:00

Physics in passive devices:The applications of physics in materials, modeling, and design



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Abstract :

Passive devices play important roles in power electronics, which deals with electrical power transmission and conversion. For example, the electrical power transmitted from grid (~10 kVAC, ~100 MW) to CPU /GPU (<1 VDC, ~1 kW) needs 3-6 times of conversions, and each conversion needs power inductors (or so-called chokes), high-frequency transformers, and power capacitors. In the development of these passive device, physics play a crucial role on the materials, modeling and design. In this talk I will share several examples with real cases.

Materials: Ferrite and soft magnetic composite (SMC) Soft magnetic materials, with 20-80000 relative permeability under frequency from kHz of 100MHz is the key for the power inductor and transformer, respectively. The development of materials needs solid state physics, micromagnetism, electro-magnetism collaborates with organic & inorganic materials science. Characterization is another field needs strong physics background.

Modeling: The vector-based, non-linear and relaxation nature of magnetic materials become the main obstacle of core loss modeling. The simplification of FEM simulation (or down-grade model) is also necessary to find the design window mentioned afterwards.

Design: The materials and process limitation, and the requirement form power conversion system give a vague, unclear but narrow design window of choke and transformer. Multiphysics simulation integrated with circuit design should be considered during design and negotiation with module designer of power converter.