
Power and Energy Systems



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website: <https://engineering.purdue.edu/ECE/Research/Areas/PEDS>

PES Personnel



Steve
Pekarek



Dionysios
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Sudhoff



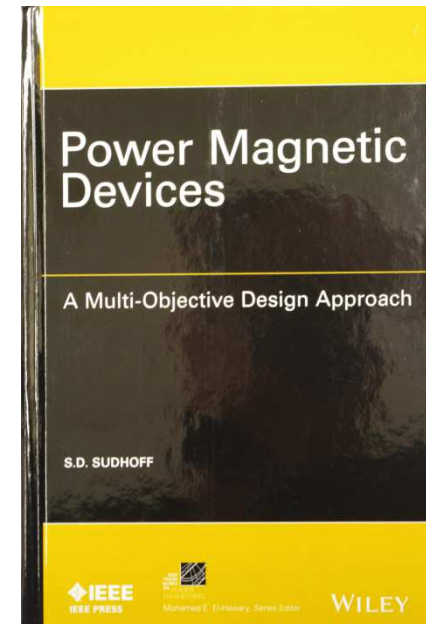
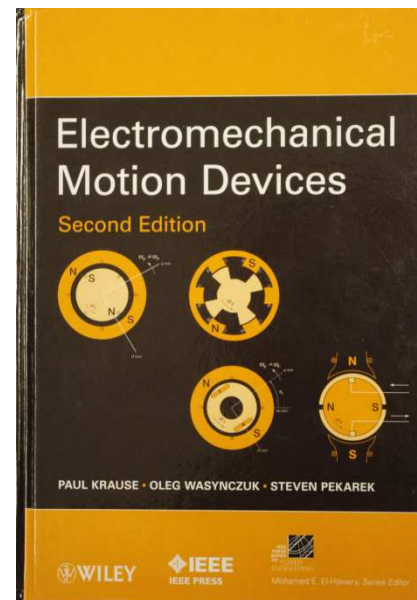
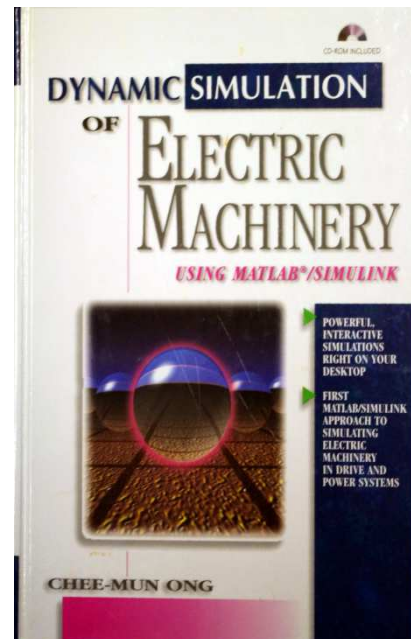
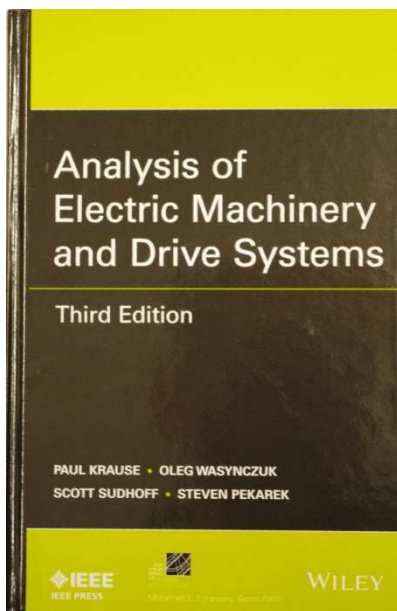
Oleg
Wasynczuk

- One full time research engineer
- Approximately 50 students/year are in Graduate Program
- Approximately 30 students/year are in Undergraduate Program₂

PES Collaborators

- ME
 - Greg Shaver (drive train)
 - Chuck Krousgrill (structural)
 - Peter Meckel (thermal)
- Materials
 - Kevin Trimble (high-Si steel)
 - Bryon Pipes (composites for high-speed machines)
- ABE
 - Andrea Vacca (electrohydraulics)

Books by PES Faculty



Research Topics

- Electrification (since 1980's)
- Wind Power Energy Conversion
- Electric Vehicles / Hybrid Electric Vehicles
- Electric Machine Design
- Power Magnetics (Transformers, Inductors)
- Power Electronics
- Control of Machines, Drives, Power Electronics
- Acoustic/Vibration Control in Electric Drives
- System and Component Modeling and Sim.

Purdue Contributions

- Reference Frame Theory (Arb. Ref. Frame)
- First Solid State Distribution Transformer
- DC System Stability and Generalized Immittance Based Stability Analysis
- Mesh Based Magnetic Equivalent Circuit
- Economic Closed Loop Torque Control
- Automated State Model Generator
- Distributed Heterogeneous Simulation
- Machine Analysis, Simulation, and Design Paradigms

PES Laboratories

- Grainger Energy Conversion and Microgrid Laboratory
- Grainger Power Magnetics Fabrication Laboratory
- Energy Storage and Material Characterization Laboratory
- Electric Vehicle Systems Laboratory
- Energy Systems Simulation Laboratory
- High Speed Machines Laboratory
- Alternative Energy Grid Integration and Systems Laboratory
- Power and Energy Design Laboratory
- Special Projects Laboratory

Grainger Power Magnetics Fabrication Facility



Laser cutter



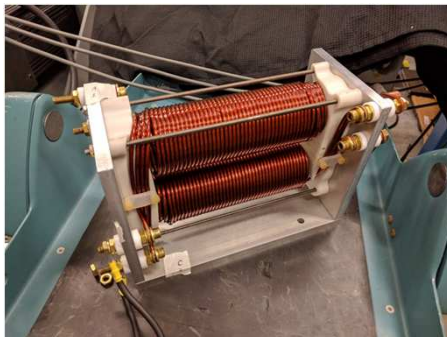
Winding machine



Stator assembly station



Annealing furnace and varnishing oven



Common mode inductor for
1 kV 50 kVA PV inverter



Utility-side and inverter-side 3-phase ac
inductors for 1 kV 50 kVA PV inverter

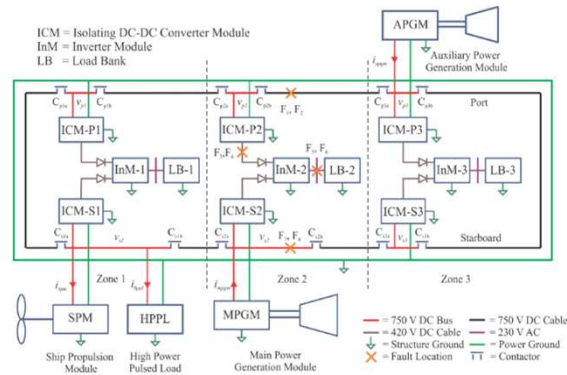


Purdue One – A Surface-Mounted
Heterogeneous-Pole PM Machine

Grainger Energy Conversion and Microgrid Laboratory



Laboratory Overview



Purdue Reduced Scale Naval DC Microgrid Topology



37 kW Ship Propulsion Motor (SPM)



57 kW Main Power Generation Module (MPGM)



9 kW Auxiliary Power Generation Module (MPGM)



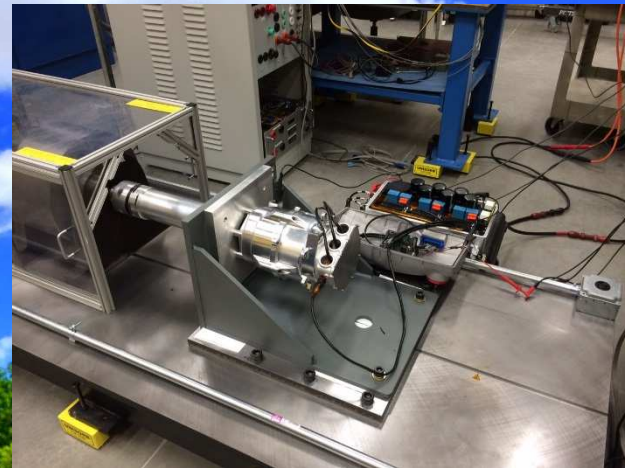
Zone 2 (left) and 18 kW Pulsed Power Load

PES Design Toolboxes

- Matlab based, open source
- Distributed by Purdue, ESRDC, Wiley
- Five public toolboxes with over 2500 combined downloads, not including Wiley and ESRDC distributions
- 70 domestic users including ABB, Rockwell Automation, SolarBridge, SEL, Sunpower, and Tesla
- 190 international users
- Two licensed toolboxes generating \$50K in royalties annually.

PES Design Codes in Action

PARAMETER	McLaren	HMI
Maximum Drive Torque (Nm)	130	205
Maximum Regenerative Torque (Nm)	130	205
Maximum Power (kW)	200	250
ALPHA	1.25	1.43
Thermal Runtime at Peak Power (min)	3	10
Efficiency at 200kW	91	97.5
Continuous Runtime Power (kW)	150	170
eMotor Mass without Cabling (kg)	26	24
Equivalent eMotor Tq Density (Nm/kg)	5	8.54
Specific Power (W/kg)	7.69	9.4
eMotor Volume (L)	6.8	6.4



HMI Machine Design by PES Faculty

PES Design Codes in Action



Propulsion Motor Design by PES Faculty

PES Design Codes in Action



Kohler Power System Machines
5 kW-200 kW

PES Design Codes in Action



Borg Warner Integrated Belt/Alternator Starter (IBAS) 14

PES Design Codes in Action

