Introduction of the Power Program at USF

Graduate Student Orientation

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Outline

• Student success stories
  ◦ PH.D & M.S. students

• Job market: Skills required

• What USF can offer:
  ◦ A top-notch power program, a solid curriculum with challenging courses
A quick overview of the undergraduate program

- Approximately 20-30 students per year specializing in power
- Four students received IEEE Power & Energy Society Scholarship ($2000 per year)
- A state-of-the-art teaching lab with HIL testbeds
- Almost all got jobs in the industry
Student success stories

• Ph.D. students
  ◦ Industry:
    • Consulting: EATON, ACLARA, GE, Alstom, ABB, PWR solutions,
    • Utilities: South Edison California, ONCOR (Texas Austin)
  ◦ Academic:
    • Penn State Harrisburg (Assistant Professor)
    • UC San Diego (post doc)
    • U. of Tennessee Chatanooga (Assistant Professor)
Past students & job placement

PH.D. graduates

- Hossein Ghasempour, Ph.D. Dec. 2016, Eaton, Minneapolis
- Javad Khazaei, Ph.D. July 2016, Penn State Harrisburg, Assistant Professor
- Lakshan Piyasinghe, Ph.D. Dec. 2015, Aclara, St. Louis.
- Ling Xu, Ph.D. awarded in Dec. 2013, Alstom Grid R&D, GE, South Edison (LA, California)
- Yasser Wehbe, Ph.D. awarded in Dec. 2012, ABB, Texas
- Haiping Yin, Ph.D. Dec. 2011, PwrSolutions/Oncor, Texas Austin
- Vahid Disfani, Ph.D. Aug. 2015, Postdoc at UC. San Diego, Assistant Professor at U. of Tennessee Chatenooga

Master graduates

- Nenad Damnjanovic, Master, Black & Veatch
- Ann Balter, Master, SEL
A side note

How does the SPS Lab recruit Ph.D. students?

- Majority came from the M.S. program with outstanding academic records.
Sreeram Murali, a master student graduated in May 2016, got three job offers.

Summary
An Entry Level Electrical Engineer seeking Full time opportunities in Power Systems and Renewable Energy Industry.

Technical Specifications
Tools: MATLAB, Simulink, SimPowerSystems, AutoCAD, SKM, PSCAD, PVsyst, ETAP(Basics), Arduino, Microsoft Office, MI-power, MATPOWER, CVX, Microstation.

Languages: Basics of C, Embedded C.
• M.S. program 2016-2017
• LCG consulting energy online (LA California)

Skills benefited job hunting:
Power System Analysis, Optimization
Python
concepts on Power Market
Sayed A. Sadat

- M.S. student Aug. 2015-May 2017
- Published a paper to IEEE PES GM 2017
- Received two Ph.D. offers from U. of Melbourne and U. of Utah
Job Market: What do employers (high-tech) look for?

- Power engineering specialized skills
  - Knowledge
  - Software implementation (programming) skills
  - Hardware implementation skills

- General skills
  - Write well and speak well
  - Multi-task capability
  - Organizational, interpersonal

- Four example job ads
  - Power electronic control (GE)
  - Power market consultant (LCG Energy Online)
  - Two software engineer positions (GE, EATON)
Example 1 – GE Power Electronics Control

Principal Engineer: Power Electronics Controls

Business:
GE Corporate

Business Segment:
Global Research

Function:
Engineering/Technology

About Us:
GE is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive and predictive. Through our people, leadership development, services, technology and scale, GE delivers better outcomes for global customers by speaking the language of industry. At GE Global Research, we're redefining what's possible. From cutting-edge research in molecular pathology for use in personalized cancer diagnostics to programs in coal gasification and renewable power that drive clean energy solutions, our work at Global Research is world-renowned. As part of our team, you'll find yourself among nearly 3,000 scientists and engineers from every discipline in a dynamic atmosphere where you'll be constantly challenged to learn and grow. You'll have access to leaders on all levels of the organization and collaborate across the globe with the very best in the field. If you have an insatiable intellectual curiosity and the ability to articulate your vision, then join us and watch the work you do create the next generation of products and processes that will impact the globe for generations to come. At GE Global Research we redefine what's possible, finding answers to some of the world's toughest problems. Find out more at http://www.ge.com/research or http://twitter.com/GEResearch, and connect with our technologists at http://twitter.com/GEResearch. There is always an exciting new challenge on the horizon at GE Global Research because "what we imagine, we can make happen". GE offers a great work environment, professional development, challenging careers, and competitive compensation. GE is an Equal Opportunity Employer. Employment decisions are made without regard to race, color, religion, national or ethnic origin, sex, sexual orientation, gender identity or expression, age, disability, protected veteran status or other characteristics protected by law.

Role Summary/Purpose:
As the Principal Engineer specializing in controls of power electronics, you will leverage your technical expertise and experience to shape technology developments and enable the transfer of technology to the GE businesses. You will set the research strategy, create roadmaps, and lead the execution of technical projects.

Essential Responsibilities:
You will partner with domain experts from GE's businesses and global research centers to shape and deliver cutting edge solutions for scalable controls for high power and high-frequency power electronics. While focusing primarily on controls for power electronics, over the course of your career, you will architect, design, and help create real-time control solutions for GE's intelligent machines (such as gas turbines, aircraft engines and systems, medical scanners, locomotives, wind farms, subsea oil and gas equipment, lighting systems, and electrical infrastructure). You will also act as a technical mentor to junior engineers and review global programs for technical excellence. As the Principal Engineer in Power Electronics Controls, you will:
• Drive a vision and roadmap for scalable controls of high power and high-frequency power electronics
• Specify and execute research projects with GE businesses to realize implementations of this vision and roadmap
• Build strong networks with technologists and leaders at GE businesses and within GE Global Research
• Participate in identifying, planning, and developing strategies to enhance GE's competitiveness
• Collaborate with the GE Businesses to implement inventions and improvements to existing products
• Develop processes, techniques and tools to accelerate real-time, embedded system design, simulation, implementation, and integration
• Advance controls technologies through collaboration with customers, universities, government agencies, and other GE teams
• Synthesize requirements and implementation strategies for power electronics, variable speed drives, and motor controls to operate robustly in harsh environments.
Example 1 – Requirements

- Qualifications/Requirements:
  - PhD in Electrical or Electronics Engineering, Computer Engineering, Computer Science, or related discipline with minimum 10 years of related experience OR Master’s Degree in Electrical or Electronics Engineering, Computer Engineering, Computer Science or related discipline with minimum 13 years of related work experience OR Bachelor’s Degree in Electrical or Electronics Engineering, Computer Engineering, Computer Science or related discipline with minimum 18 years of related work experience
  - Experience with power electronics and classical and modern control theory
  - Experience with digital motor control, system software, and firmware development
  - Experience with simulation and modeling of embedded systems
  - Experience with FPGA logic programming and synthesis
  - Demonstrated expertise in digital signal processing, digital control, control system analysis and synthesis
  - Demonstrated core expertise in real-time, embedded systems and control platforms

Courses: Power Electronics, Digital Control Theory, Machines and Drive, RT-Lab-based lab
Example 1 - Desired Characteristics

- Extensive experience in modeling power converters and power systems using simulation tools (example: MATLAB/Simulink, PLECS, Simplorer, PSIM and/or PSCAD)
- Experience with real time simulators such as DSPACE, OPAL-RT and/or RTDS

You will experience all above software/hardware in lab & homework!
Develop core algorithms

Programming --EEL
5250 Power System Analysis
Example 3 – Eaton Lead Power System Engineer

- [https://jobs.eaton.com/jobs/036214/Ing%C3%A9nieur+en+r%C3%A9seaux+de+puissance+principal?lang=en-US](https://jobs.eaton.com/jobs/036214/Ing%C3%A9nieur+en+r%C3%A9seaux+de+puissance+principal?lang=en-US)

**Functions:**
- Leads complex power system software new product development
- Writes technical papers in leading industry conference and journals (e.g., IEEE)

**Qualification:**
- Master's degree or PhD in power systems, electrical engineering, computer science or a related field.
- Knowledge of Power Engineering Software: CYME, PSCAD, EMTP
- Excellent analytical and problem solving skills.
- Proficiency in mathematics: Linear algebra and Numerical Computation.
- Proficiency in software development: Structured and object-oriented programming
- Experience with software design process and tools, such as Matlab or Python prototyping.
- Proven track record of publication in reputable peer-reviewed journals.
- Should be recognized externally as a subject matter expert in power system simulation. This may be evident through invitations to present a technical presentation or publish in a technical journal as SME to an audience of technical/industry peers.
Example 4- LCG Senior Electricity Market Consultant

- [Link](http://www.energyonline.com/About/Files/Senior_Electricity_Market_Consultant.pdf)

- **Job description:**
  - to develop and manage consulting projects using our in house models for LMP, congestion and wind curtailment analysis.

- **Qualifications:**
  - Experience in operation research with passion for modeling and optimization
  - Knowledge of regional electric planning models, power pools and market pricing mechanisms, loads and transmission grids in one or more NERC regions
  - Academic Training in Electrical Engineering with emphasis in load flow and transmission analysis
M.S. Curriculum Design
Power Program Areas

- **Renewable Energy Integration**
  - Power Electronics *(spring)*
  - Energy Delivery Systems *(spring)*
  - Electric Machines and Drives *(Fall)*
  - *Digital Control Theory* *(Fall)*
  - Control & Optimization in Power Systems *(Spring 2018)*

- **Power System Operation**
  - Power System Analysis *(Fall)*
  - Power Systems II *(Spring)*
  - Power Market *(Spring 2019)*
  - Linear Programming *(Fall)*
  - Control & Optimization in Power Systems *(Spring 2018)*

- And **traditional utility courses**
  - Power System Protection, Power Quality, Distribution Systems

5 fundamental power courses (offered annually) cover 2 tracks.
Track 1: Renewable energy grid integration

Energy Delivery Systems (solar/wind grid integration, microgrids)

Power Electronics

Digital Control Theory

Classic control

Power Systems II (voltage/freq control)

AC machines and Drives

Electric Machines

Skills
Software: PSCAD
Hardware: HIL

EE graduate

EE undergraduate
Track 2: Power System Operation

Linear programming (fall 2017)

Integer Programming (fall 2018)

Power system analysis (fall 2017)

Power Market (sp 2019)

Optimization & Control in Power Systems (sp 2018)

Power System II (Spring 2018)

Circuits (KCL, KVL)

Control

Programming Skills
MATLAB, Python, OR tools (CVX, CPLEX)

EE graduate

EE undergraduate
Power program features

- **Excellent curriculum** that prepares students with computer-aid analysis and design skills: software and hardware
  - Software training *(PSCAD)* in power systems & power electronics courses
  - Programming and software training *(Matlab, Python, OR tools)* in power systems & power market
  - Hardware training in machine and control courses *(HIL)*

- **Excellent teaching lab/facility**
  - Opal-RT real-time simulators enabled Hardware-in-the-loop *(HIL)* testbed
RT-LAB Enabled Drive Lab
Examples

- LCG Market Consultant position
  - Load flow & transmission analysis
    - EEL 5250: Power System Analysis (Fall 2017)
    - Linear Algebra, Numeric Computation, Matlab/Python prototype programming
  - Pricing mechanism, Operation Research (how to solve optimization problems)
    - advanced: Power Market (Spring 2017, 2019)
      - Optimization problem formulation, solving, interpretation
    - advanced: Control and Optimization in Power Systems (Spring 2018)
Supporting Mathematics

- Linear programming
  - ESI 6491: IMSE dept: LP & Network Optimization (Fall 2017)
Example: Eaton Lead Engineer

- Power system simulation: PSCAD (EMTP), linear algebra, numerical computation, Matlab/python, publications
  - The broad definition of simulation and the requirement of PSCAD indicate that both tracks (6 power courses + 1 control course + 3 math courses) are needed.
  - In addition, write a paper.
Thank you!

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