ECE 630 – Special Topics: Engineering Analysis and Design Using Genetic Algorithms

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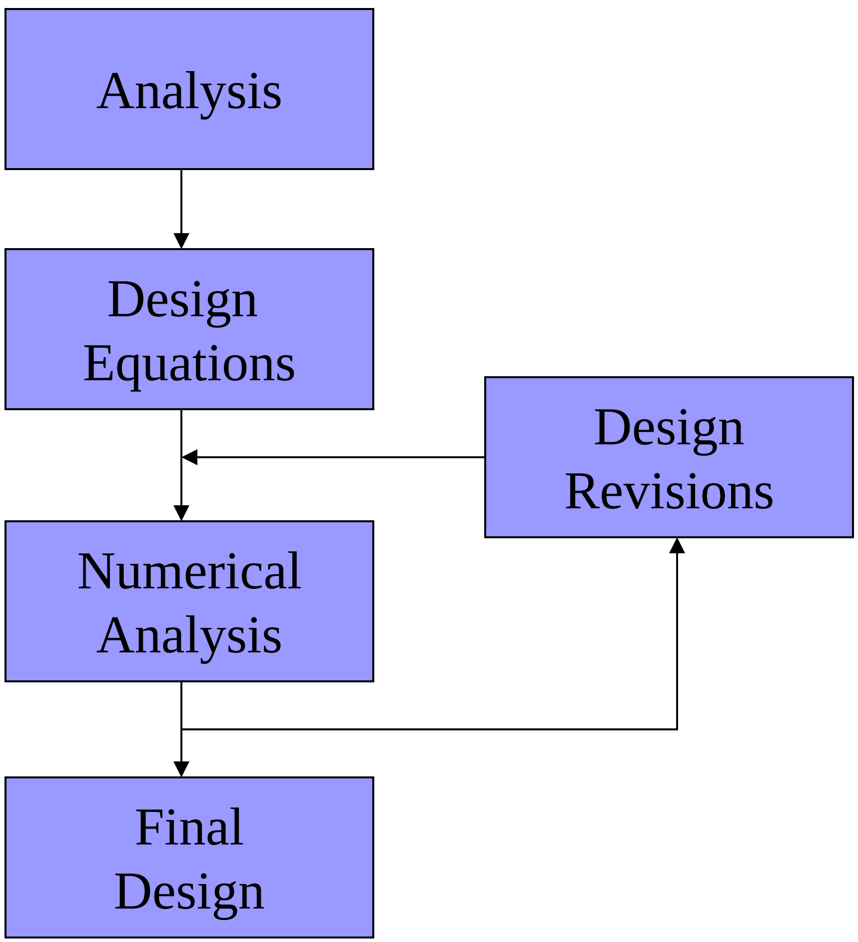
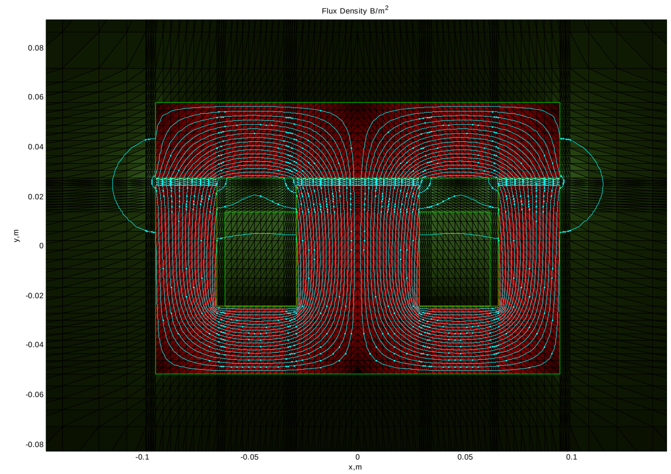
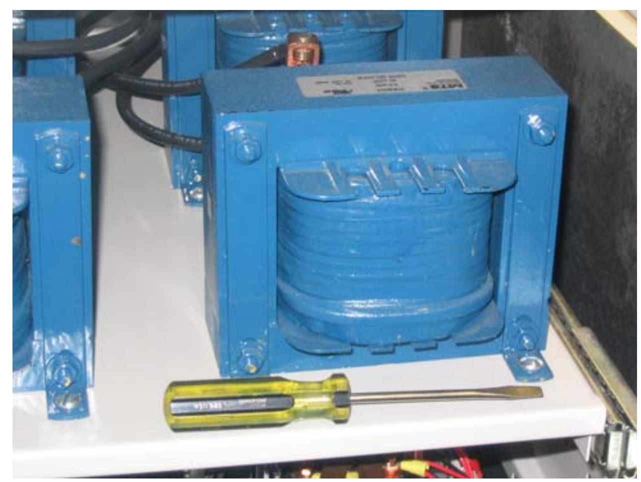
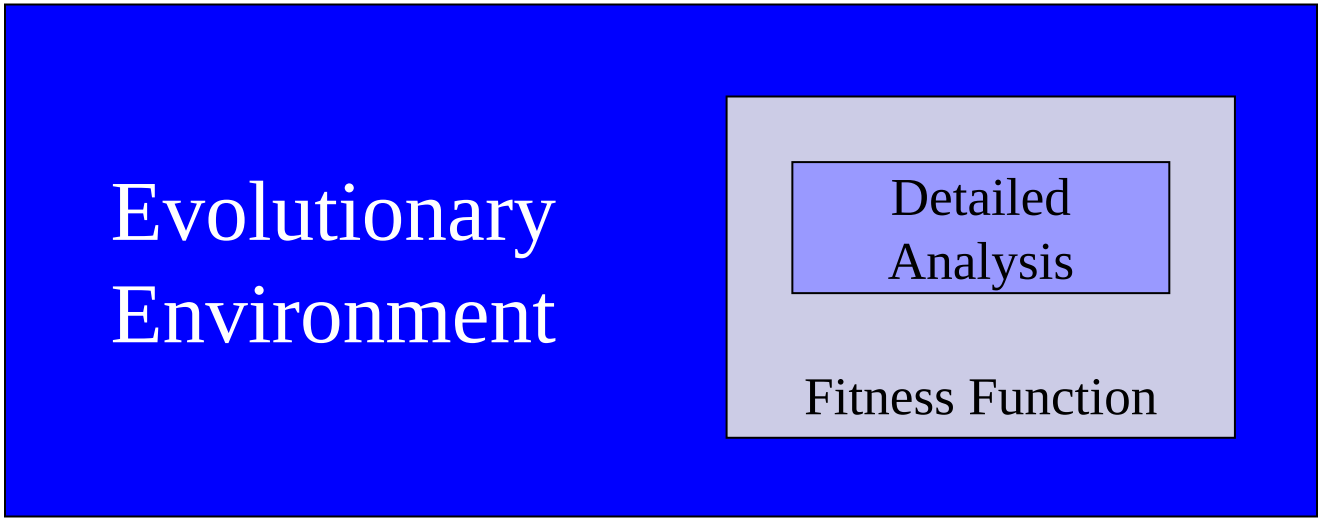
Manual Design Approach







Evolutionary Design Approach



Optimization Based Design and Analysis (Evolutionary or Otherwise)

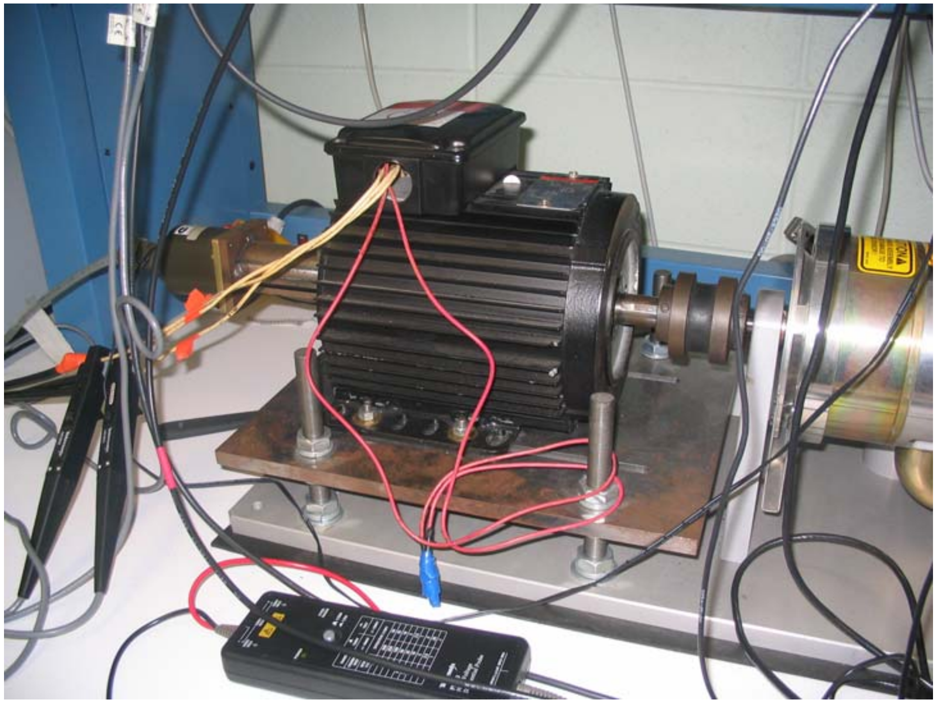
- Pose Design Problem As An Optimization Problem
  - Can be single or multi-objective
  - Systematically encode design constraints and objectives into fitness functions
- Reality Check: Problem Properties Not Always Friendly
  - Not differentiable
  - Not convex
  - Many local extrema
  - No unique global optimum

Optimization Methods

- Classic Methods
  - Newton's Method
  - Gradient Methods
  - Conjugate Direction Methods
  - Quasi-Newton Methods
  - Nedler-Mead Simplex Method
- Populations Based Methods
  - Monte-Carlo
  - Population Based Classical Methods
  - **Genetic Algorithms**
  - Swarm Algorithms

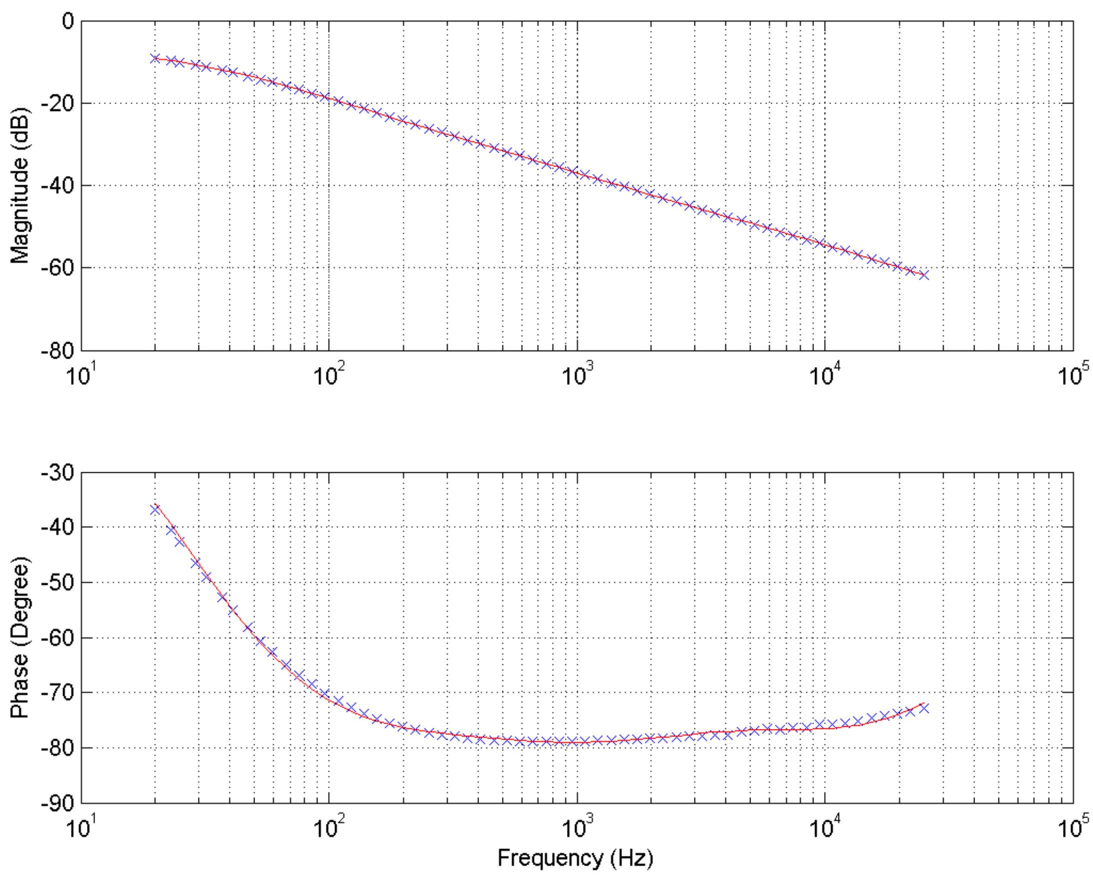
Electric Machine Design

Rotor Material Type: Superflux
Stator Material Type: Superflux
Permanent Magnet Type: NdFeB-30
Current Phase Advance (Degrees): -56.9791
Permanent Magnet Fraction (Percent): 94.9762
Rotor Iron Radius (cm): 2.5304
Permanent Magnet Depth (cm): 0.12325
Air Gap (mm): 0.35252
Slot Depth (cm): 1.075
Depth of Backiron (cm): 0.60912
Active Length (cm): 5.1814
Number of Slots: 32
Fundamental Turns Density (turns/rad): 0.6194
3rd Harmonic Turns Density (percent): 41.112
Conductor Type: Copper
Conductor Area (mm^2): 1.3129

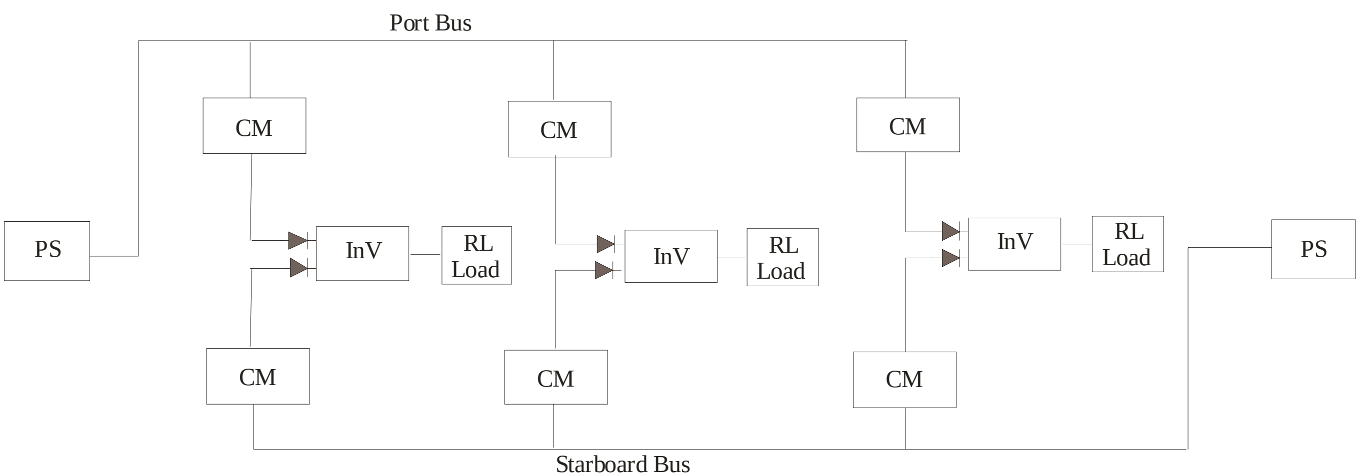


S.D. Sudhoff, J. Cale, B. Cassimere, M. Swinney, “Genetic Algorithm Based Design of a Permanent Magnet Synchronous Machine,” 2005 International Electric Machines and Drives Conference, San Antonio, Texas, May 15-18, 2005

Transfer Function Identification

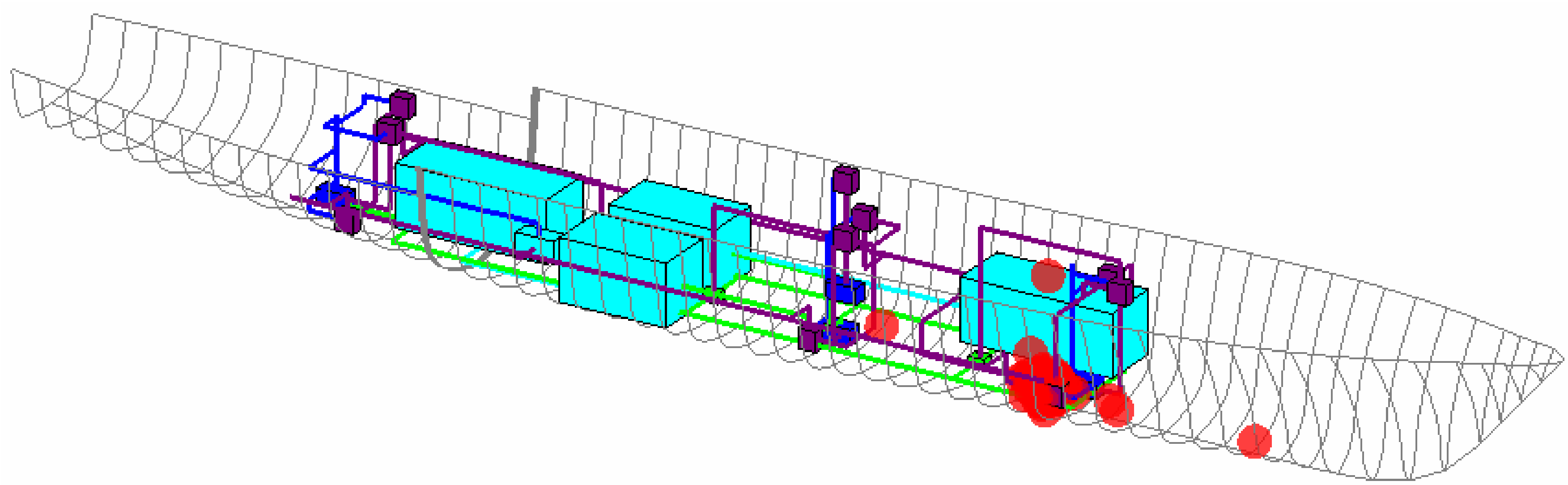


NCS/IFTP Control Design



$$\theta_c = [K_{pv}\ \ K_{iv}\ \ K_{ii}\ \ \tau_{invc}\ \ \tau_{invout}\ \ \tau_{iniout}\ \ K_{sf}\ \ \tau_{sf1}\ \ \tau_{sf2}\ \ K_v\ \ \tau_v\ \ K_{ip}\ \ K_{id}]^T$$

Vulnerability Assessment



Course Outline

- Lecture 1: Biological Genetics and Evolution
- Lecture 2: Canonical Genetic Algorithms
- Lecture 3: Schema Theory
- Lecture 4: Real Coded Genetic Algorithms
- Lecture 5: Genetic Optimization System Engineering Tool
- Lecture 6: Single Objective GA Exercises
- Lecture 7: GOSET Graphical User Interface
- Lecture 8: A Design Example: An Electromagnet
- Lecture 9: Multi-Objective Optimization
- Lecture 10: Multi-Objective Optimization Exercises

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For Credit Grading

- 4 Homeworks (10 % of grade, each)
- 1 Final Exam (60 % of grade)