

A Wind Driven Power-Generating System: Initial Designs and Construction

Donald Merriam Jr., S. Marthai, R. Rohe.

Physics Department
Houghton College

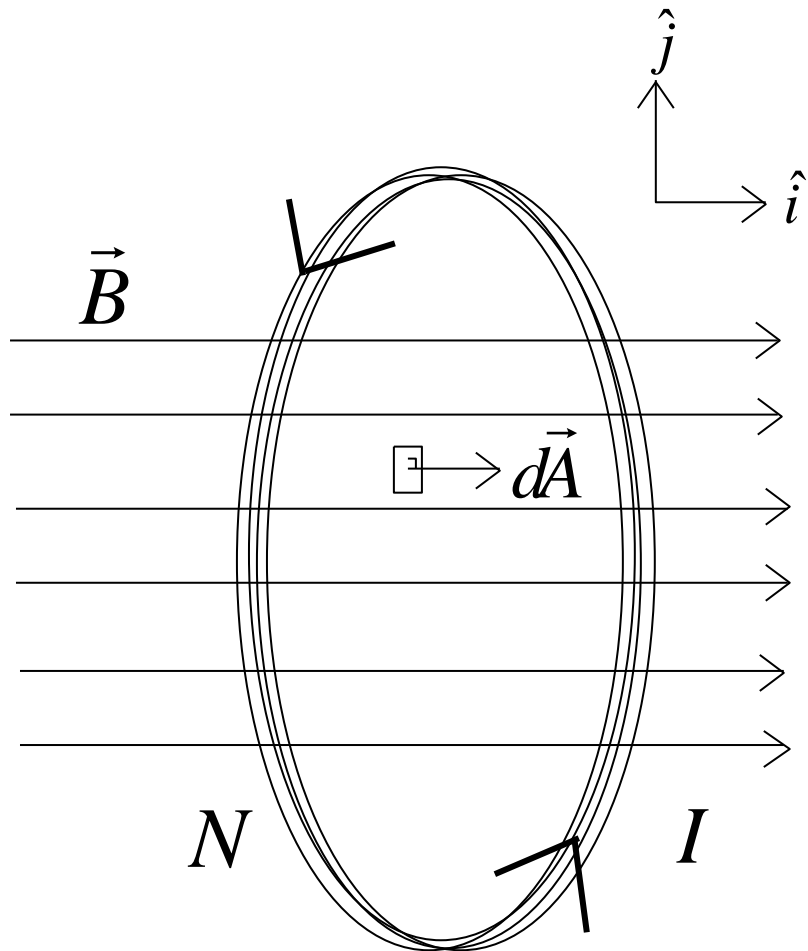
Outline

- Goal, Purpose, and Plan
- Basic Principles of Current Induction
- Previous Generator Designs
- Design and Construction
- Future Plans

Goal, Purpose, and Plan

- Goal:
 - Design and build 1 to 5 kW wind power system.
- Purpose:
 - Inexpensive, efficient, durable wind power system.
- Plan:
 - Construction and Testing
 - directly coupled, low rpm generator
 - Experimentation and Efficiency Studies (future)

Current Induction Review



$$\varphi_B = \int \vec{B} \cdot d\vec{A}$$

$$\xi = -N \frac{d\varphi_B}{dt}$$

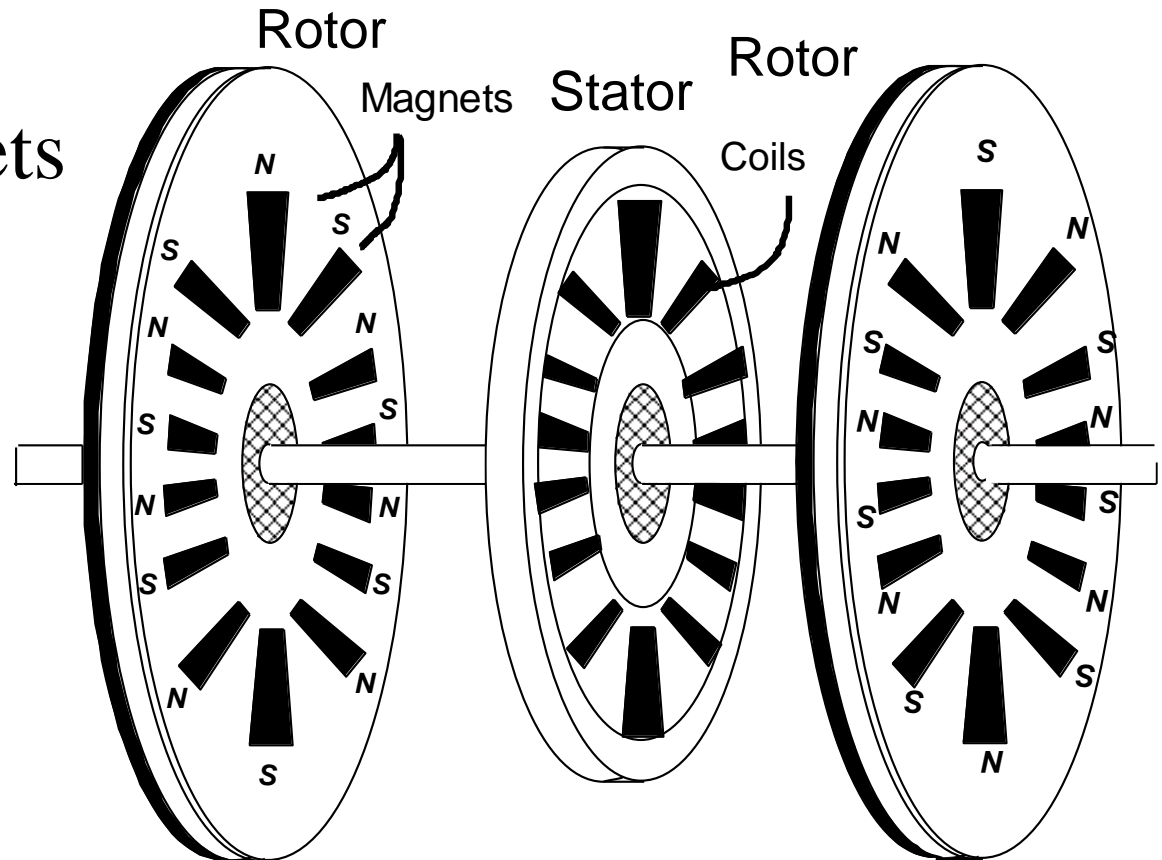
Induction in Generator

- $m = \#$ of magnets pairs
- $r = \text{rev/min.}$

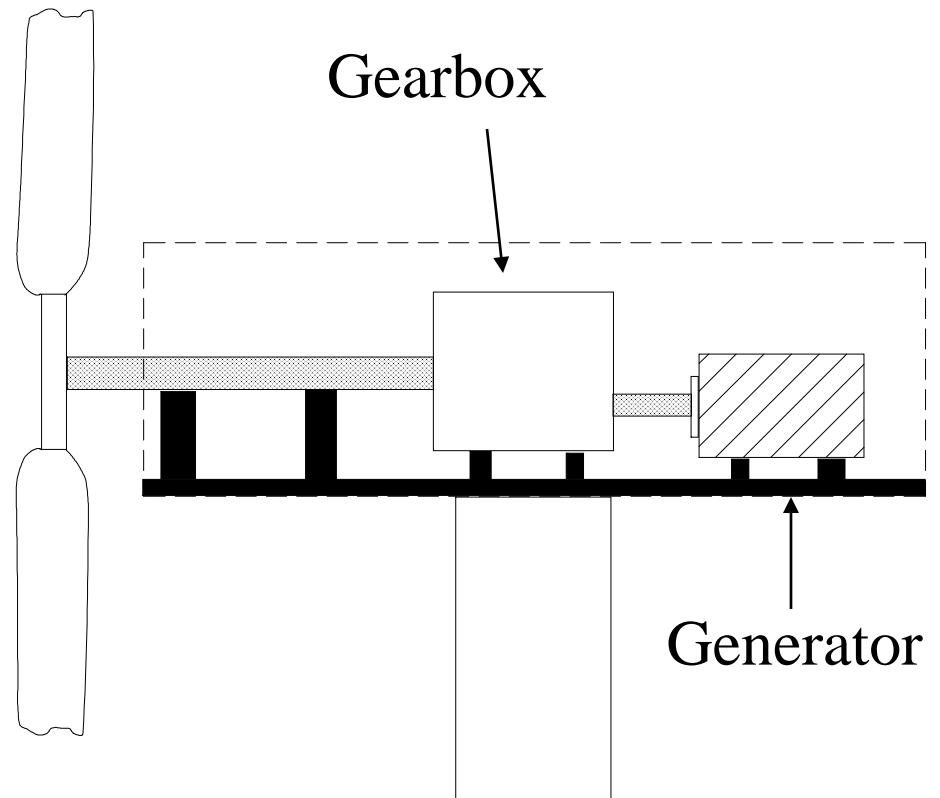
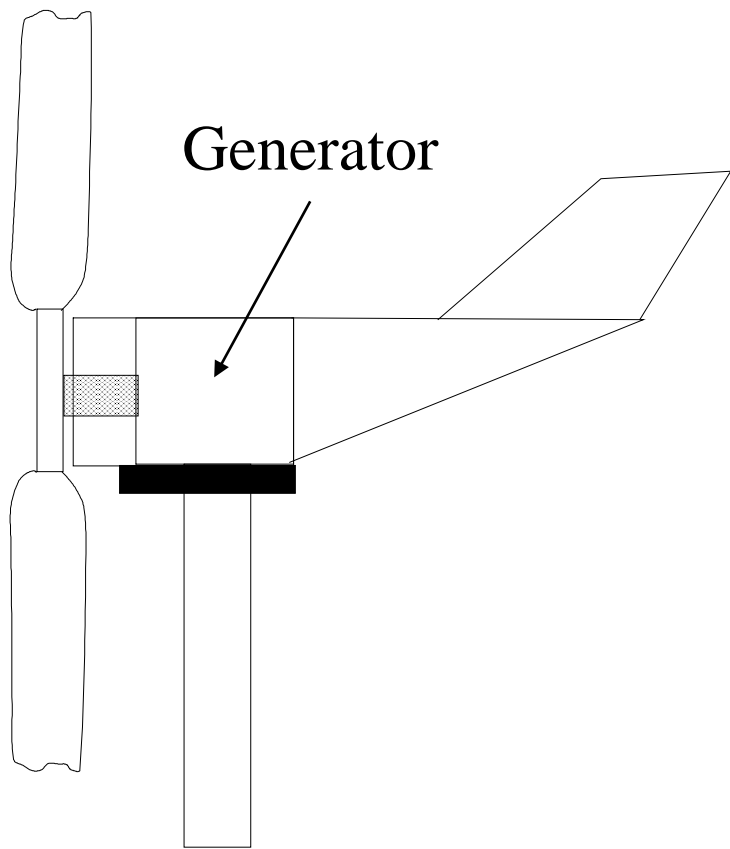
$$f = \frac{mr}{2 * 60}$$

$$\vec{B} = B_{\max} \cos\left(\frac{\pi mr}{60} t\right) \hat{i}$$

$$\xi = \frac{\pi}{60} N A m r B_{\max} \sin\left(\frac{\pi mr}{60} t\right)$$

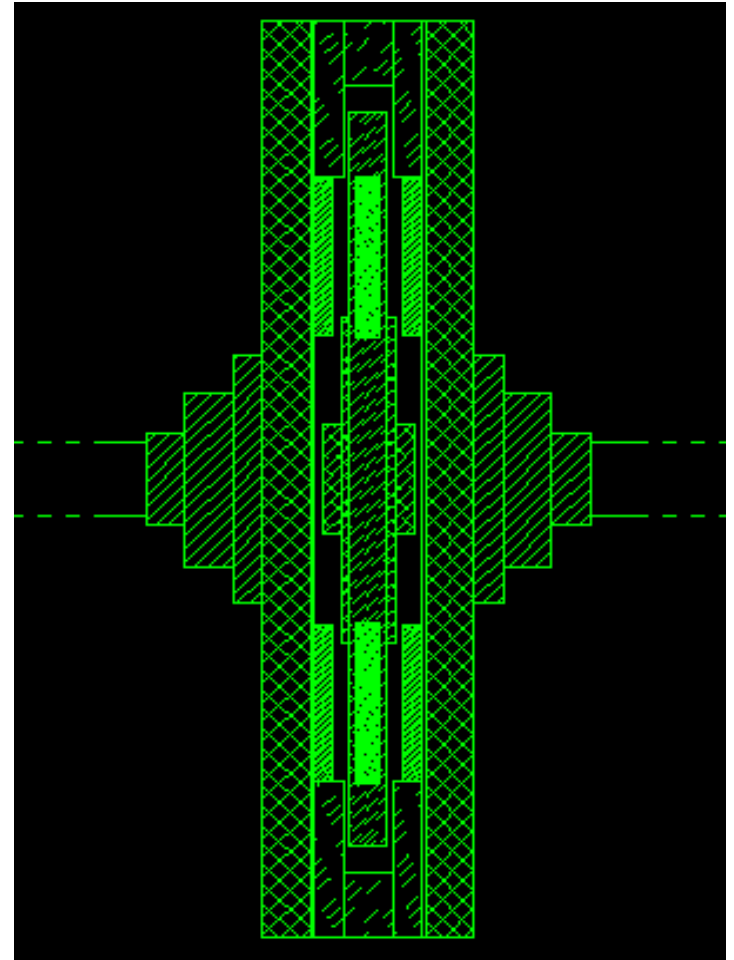
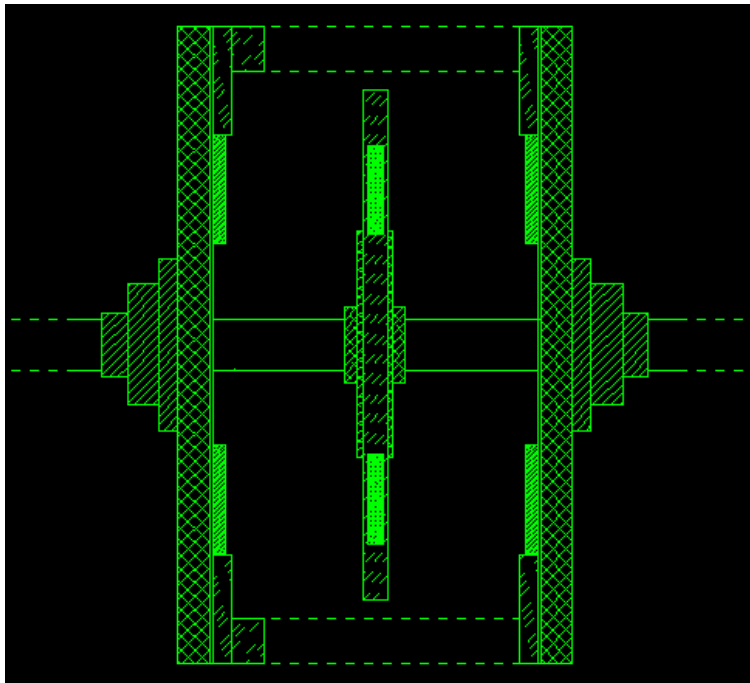


Direct Coupling vs. Gear Coupling



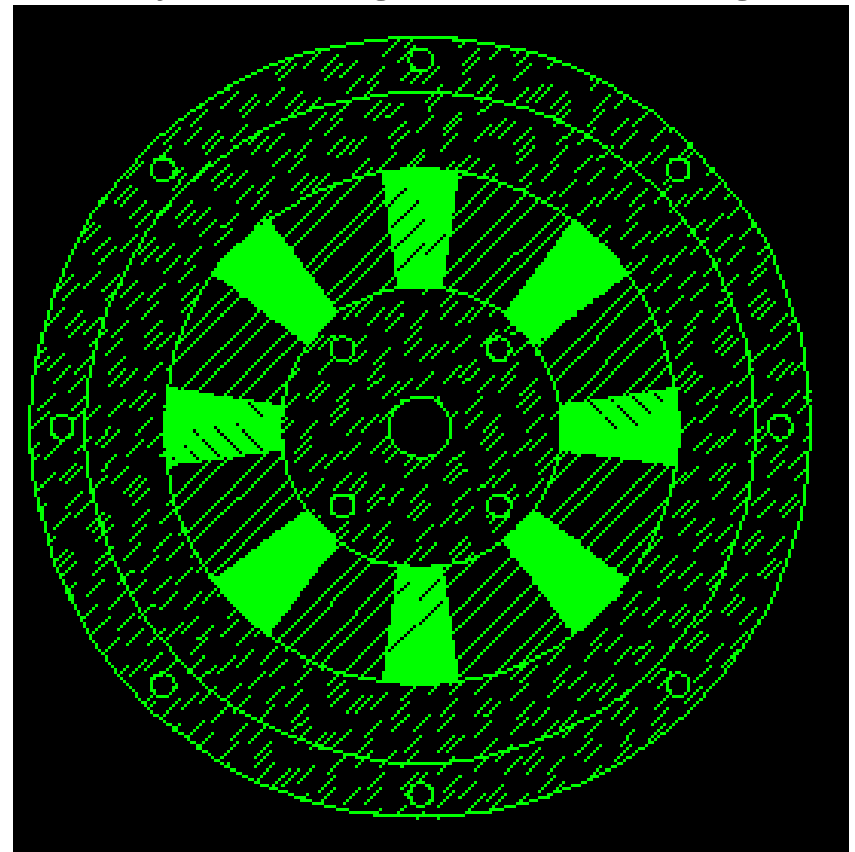
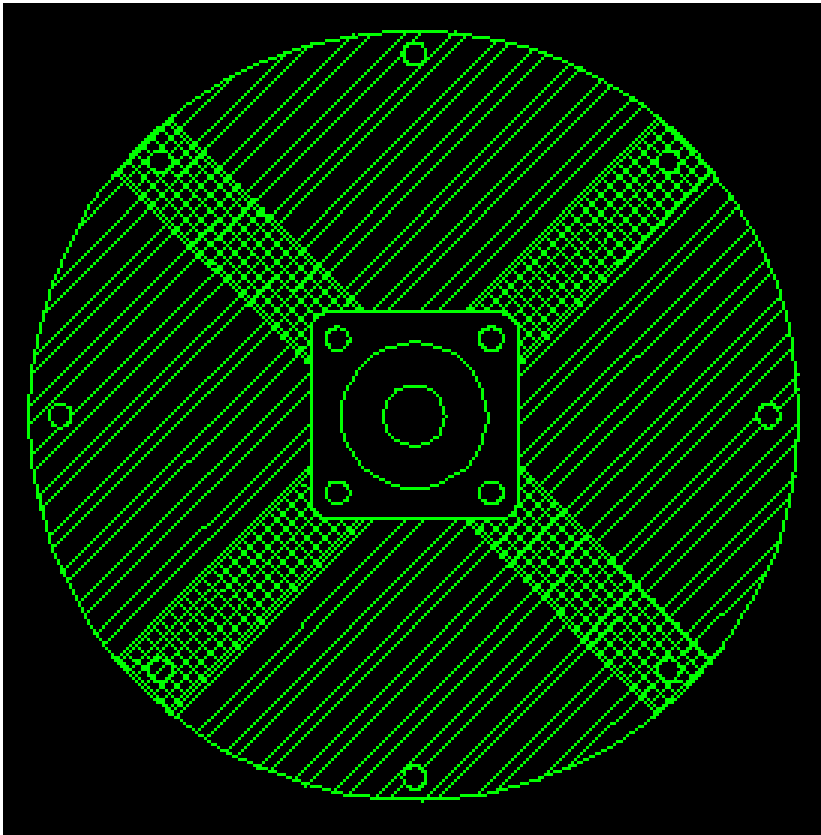
Design and Construction

- Generator
 - Rotor
 - Stator
 - Magnets
 - Coils



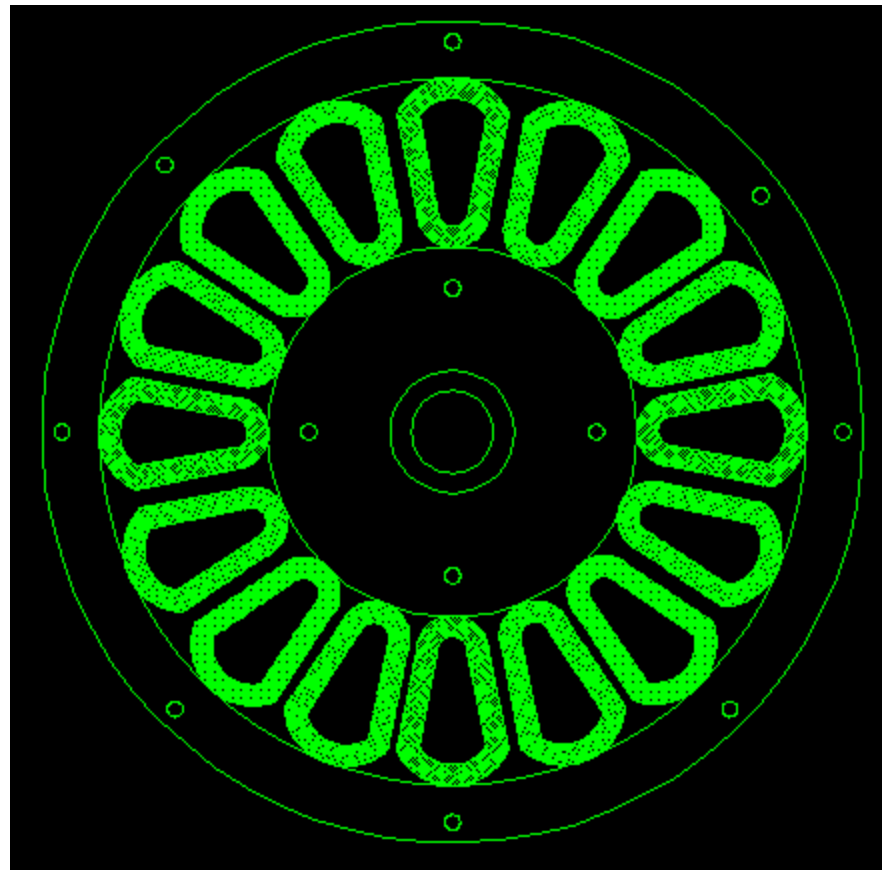
Rotor Design

- Bearings
- Angle Iron Support
- Sheet Metal for magnets
- Acrylic ring for housing



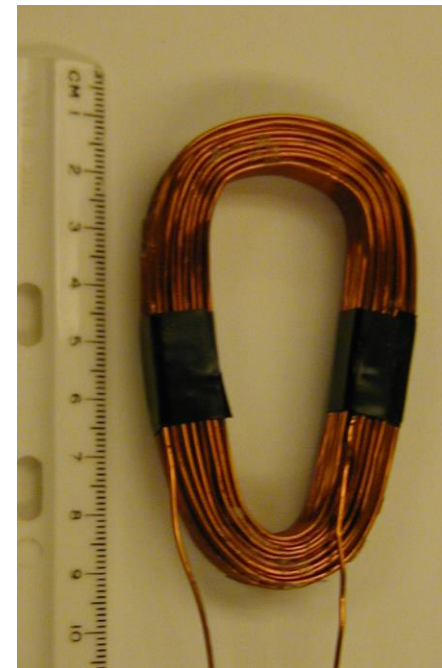
Stator Design

- Aluminum Support
- Acrylic ring for housing
- Twice as many coils as magnets pairs



Magnets and Coils

- Neodymium Iron Boron (NdFeB) magnets
 - Strength: 0.26 T
 - » Measured at the center for separation of 3.5 cm.
- Coils
 - Wire: 19 gauge - copper
 - Turns: 120
 - Resistance: 0.52 Ohms
 - Flux Surface Area: 30 cm²

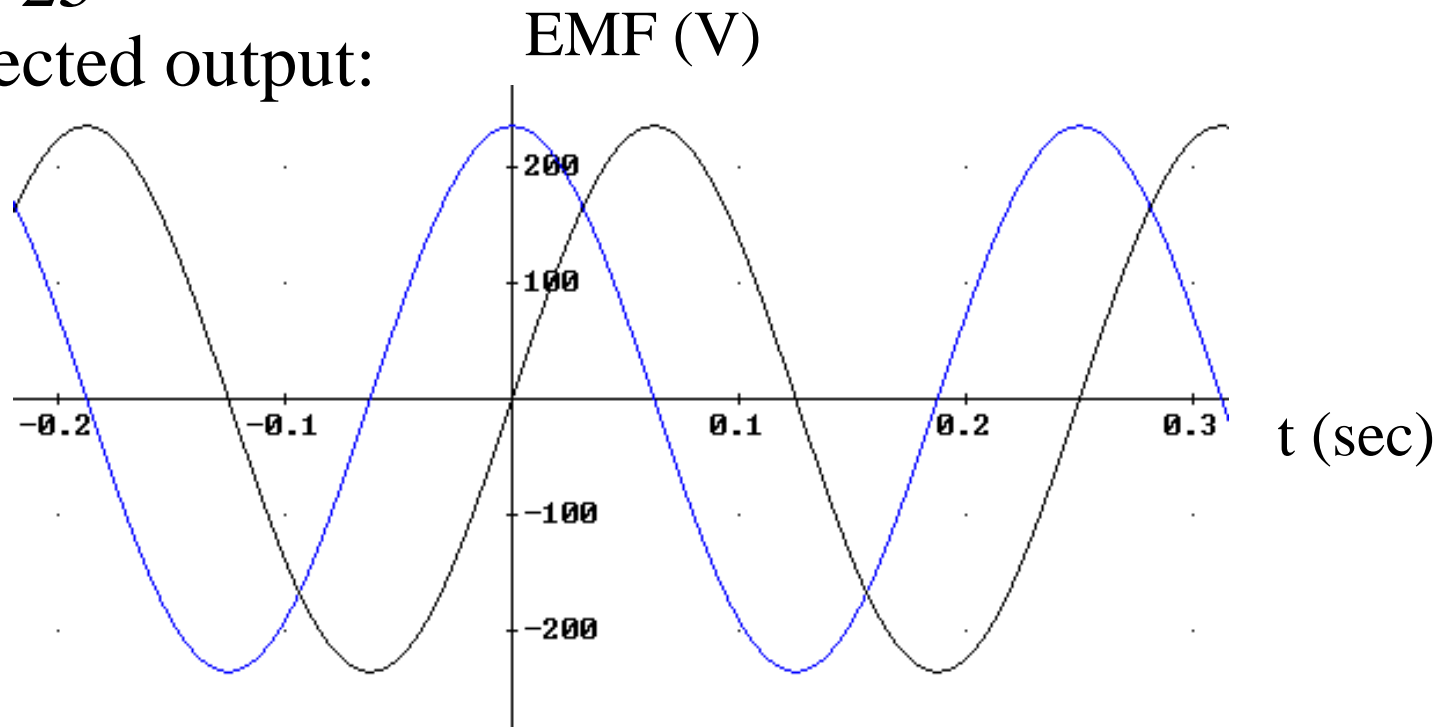


Expected Unloaded EMF

- For: $N = 120$ turns $A = 30 \text{ cm}^2$
 $m = 8$ magnets $r = 60 \text{ rpm}$

$$\xi = \frac{1872}{25} \pi \sin(8\pi t) \text{ V}$$

– Expected output:



Plans

- Continued Construction and Testing
 - Table-top experimentation

- Further Considerations
 - Electrical circuit for power output
 - Blade design and attachment
 - Wind resistance
 - Mounting