

# SPH 3U1

## Culminating Task 2010

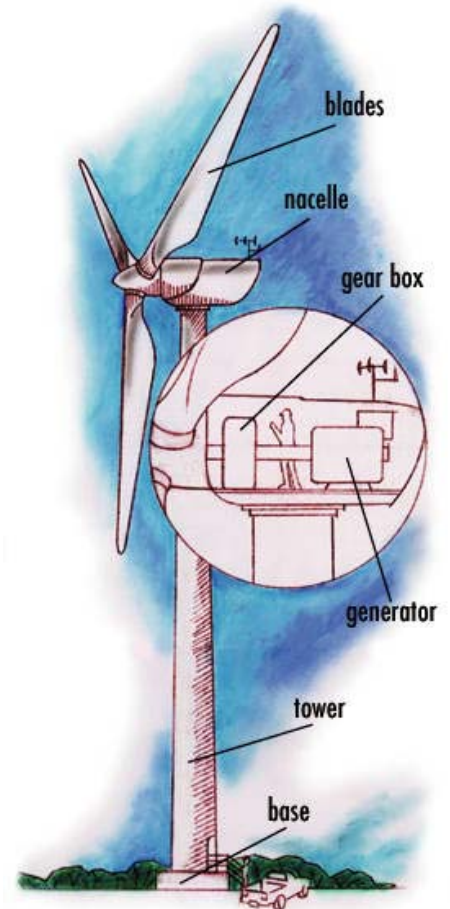
### Sustainable Power Wind Turbines

#### Our Task Objectives:

- Build an Electric Generator
- Build a Windmill
- Test in the Wind Tunnel

#### The Wind Turbine Design and Requirements

- ✘ The wind turbine will consist of a generator and a turbine blade system, mounted on a tower, that you design and create (no pre-fabricated parts).
- ✘ Each team will design the blades to be attached to the motor (no pre-fabricated parts) so that they fit within the diameter of the wind tunnel.
- ✘ It is expected that you will design at least three different blade systems to attach to the motor so that you can test and compare them quantitatively in the wind tunnel.



#### Research

- Every individual will research and report on the possibility of using wind turbines as a source of producing green energy in Canada. You might want to include information
- a) about where Canada is today and where it might be in 2050 with the use of wind energy,
- b) on economic benefits,
- c) on health benefits,
- d) that compares various designs for wind turbines,
- e) about how other countries are progressing with this renewable form of energy,
- f) on local use of wind turbines for homes ...
- Your report should be brief and to the point. It should summarize the information in one page single spaced.

## Experimentation

- Once your tower and blade systems are constructed, you will test each of the blade systems in the wind tunnel. You will also connect the wind turbine to a resistor so that the power output can be measured by determining the voltage across the resistor and the current in the circuit.
- Each team will make the observations together, but analyze the data individually during class time since this is a summative evaluation.
- Write up the experiment as a report using the lab report format.
- Draw a schematic diagram of the system when connected to the resistor.
- **Observations:** Completed in teams.
- Complete the following for each blade system and document your measurements in an appropriate table.
  1. Determine the wind speed in the wind tunnel that you will be using.
  2. Determine the power available in the wind by measuring the wind speed used in the wind tunnel and the formula  $P = \frac{1}{2} d A v^3$  where  $P$  is the power in Watts per meter squared,  $d$  is the density of air in kilograms per cubic meter ( $1.3 \text{ kg/ m}^3$ ),  $A$  is the area swept out by the blades, and  $v$  is the velocity of the wind in meters per second.
  3. Determine the actual power generated by the wind turbine when it is connected to a resistor for blade system.
  4. Determine the power efficiency of your wind turbine for each blade system (i.e. compare the power available in the wind to the actual power generated).
- **Analysis:** Completed individually.
- Once the above information has been collected complete the following:
  - Plot graphs of the power output versus the wind speed for each blade design.
  - Plot graphs of the power efficiency of the turbine versus the wind speed for each blade design.
  - Compare the different blade designs based on the above graphs. Where do they differ in performance? Where are they the same? What physical characteristics might account for the value of the power efficiency?
  - How does the power available in the wind compare to the power generated by the turbine? Suggest reasons for any discrepancies.
  - Write a detailed description of how your wind turbine produces electrical current and discuss all the energy transformations that occur starting from the wind.

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### Marking Scheme:

For each criteria category your work will be assigned a level of performance. Each achievement category will be assigned a mark based on the most consistent level. This evaluation will follow the overall course breakdown and be worth a total of 33.33% of your Final Assessment or 10% of your Final Grade.

Criteria	Level 1	Level 2	Level 3	Level 4
<b>KNOWLEDGE</b>				
Facts and Terms	Demonstrates limited knowledge of facts and terms	Demonstrates some knowledge of facts and terms	Demonstrates considerable knowledge of facts and terms	Demonstrates thorough knowledge of facts and terms
Understanding of concepts, principles, laws and theories	Demonstrates limited understanding of concepts, principles, laws, and theories	Demonstrates some understanding of concepts, principles, laws, and theories	Demonstrates considerable understanding of concepts, principles, laws, and theories	Demonstrates thorough understanding of concepts, principles, laws, and theories
<b>INQUIRY</b>				
Schematic, Apparatus, Diagram	Drawings are incomplete, labeled poorly	Drawings have minor errors, labeled poorly	Drawings have minimal errors and are labeled	Drawings are accurate and clearly labeled
Recording results:  Observations, tables, graphs	Recordings are disorganized and contain major errors or omissions	Recordings are somewhat organized and contain several major errors or omissions	Recordings are organized and contain few minor errors and/or omissions	Recordings are relevant and organized effectively. Tables have appropriate headings and units. No errors.
Analysis and Interpretation	Provides limited analysis and/or incorrect answers to questions	Provides some analysis and/or some correct answers to questions	Provides considerable analysis and/or mostly correct answers to questions	Provides insightful analysis and/or correct answers to questions
Sources of error	Limited analysis of errors	Some analysis of errors	Considerable analysis of errors	A high degree of analysis of errors

<b>COMMUNICATION</b>				
Information and Ideas, Clarity	Generally unclear	Moderately clear	Considerably clear	High degree of clarity
Scientific Terminology	Uses terminology with limited accuracy	Uses terminology with some accuracy	Uses terminology with considerable accuracy	Uses terminology with a high degree of accuracy
Written Work	Written work demonstrates limited organization	Written work is somewhat organized	Written work is organized	Written work is organized and polished
<b>APPLICATION</b>				
Social, Economic and/or Environmental Issues	Analyses and assess issues with limited effectiveness	Analyses and assess issues with moderate effectiveness	Analyses and assess issues with considerable effectiveness	Analyses and assess issues with a high degree of effectiveness
Connections among science, technology, society & environment	Shows limited understanding of connections in familiar contexts	Shows some understanding of connections in familiar contexts	Shows considerable understanding of connections in familiar and unfamiliar contexts	Shows thorough understanding of connections in familiar & unfamiliar contexts

**Comments:**