

Wind Turbine Design Project

Spring 2008

Humans have harvested energy from the wind for centuries. Sails for ships, windmills for grinding grain or pumping water are a few examples. There is renewed interest now in harvesting energy from the wind, because it offers a pollution-free means of generating electricity on a significant scale. The system that accomplishes the conversion of wind energy to electricity is called a *wind turbine*.

This semester you will design and construct a wind turbine and explore some of the engineering principles involved. The project will consist of four major activities:

- Designing and fabricating the turbine rotor blades
- Designing and fabricating the support tower
- Determining the power output by your turbine
- Measuring the stiffness of your support tower

Grading of the project will be carried out using the following criteria:

- **Power generated** (45%) Your wind turbine will be tested at two wind speeds, high and low. The higher the power output in both regimes, the better.
- **Stiffness of support tower** (25%) Your support tower will be loaded transversely (simulating wind loading), and its deflection will be measured 18 inches above the base of the tower. The less deflection, the better.
- **Weight of structure** (20%) Your structure will be weighed. The lighter, the better
- **Creativity** (10%) This aspect will address innovation and creativity used in your design.
- **Presentation on the design and its performance** You will make a 5 to 10 minute presentation describing your design and the results of its performance. (See the guidelines for the presentation below).
- **Report on the design and its performance** You need to document your design and performance results in a written report. Your report will be assessed on the quality and completeness of your documentation. (See the guidelines for writing the report below and the [rubric](#) that describes how your report will be evaluated).

Contest

Bonus points will be given for the wind turbine that generates the most power, is the lightest, and has the highest stiffness.

Details on Activities for the Wind Turbine Project

Lab Assignment 3 – Learning How to Design with Solid Modeling Software

In this laboratory period, you will get some training in three dimensional computer-aided design using Inventor 2008, a leading-edge solid modeling software. You will begin to apply what you've learned to design the blades for your wind turbine.

[Note: the Inventor 2008 software is available for students to download and use for free. Follow the instructions for how to download Inventor 2008 that are given on the Blackboard site for E10. Look under the Laboratory organizer, then click on 'How to Download Inventor 2008']

Lab Assignment 4 - Designing And Fabricating The Turbine Rotor Blades

Building on what you learned from the previous lab assignment, in this laboratory, you will design and fabricate your turbine rotor. Before you come to lab, you should do some research on wind turbine blades to decide on the best cross section, how the blade should be shaped, how many blades, etc.

Lab Assignment 5 - Designing And Fabricating The Wind Turbine Support Tower

The goal of this assignment is to design and fabricate a support tower for your wind turbine. You will be given a base and upper support plate between which you need to design a supporting structure. The dimensions and orientation of the support plates and their required spacing is shown in Figure 1 below. **Important note:** find out from your laboratory instructor what restrictions will be imposed on the materials that may be used for the support structure. You may attach your structure to both support plates as needed, but they may not be otherwise modified (i.e., hollowed out, etc.)

Lab Assignment 6 - Performance Testing of the Wind Turbine and Tower

In this laboratory period, you will demonstrate the power output from your turbine and stiffness of your support tower. Your team will make a 5 to 10 minute presentation describing the design and results of performance testing. (See the Guidelines for the Project Presentation below). A report documenting your design and its

performance will be due in lab the following week. (See the Guidelines for the Project Report below).

Lab Assignment 7 - Presentation

Your team will make a 5 to 10 minute presentation describing the design and results of performance testing. (See the Guidelines for the Project Presentation below). A report documenting your design and its performance will be due in lab the following week. (See the Guidelines for the Project Report below and the [rubric](#) that describes how your report will be evaluated).

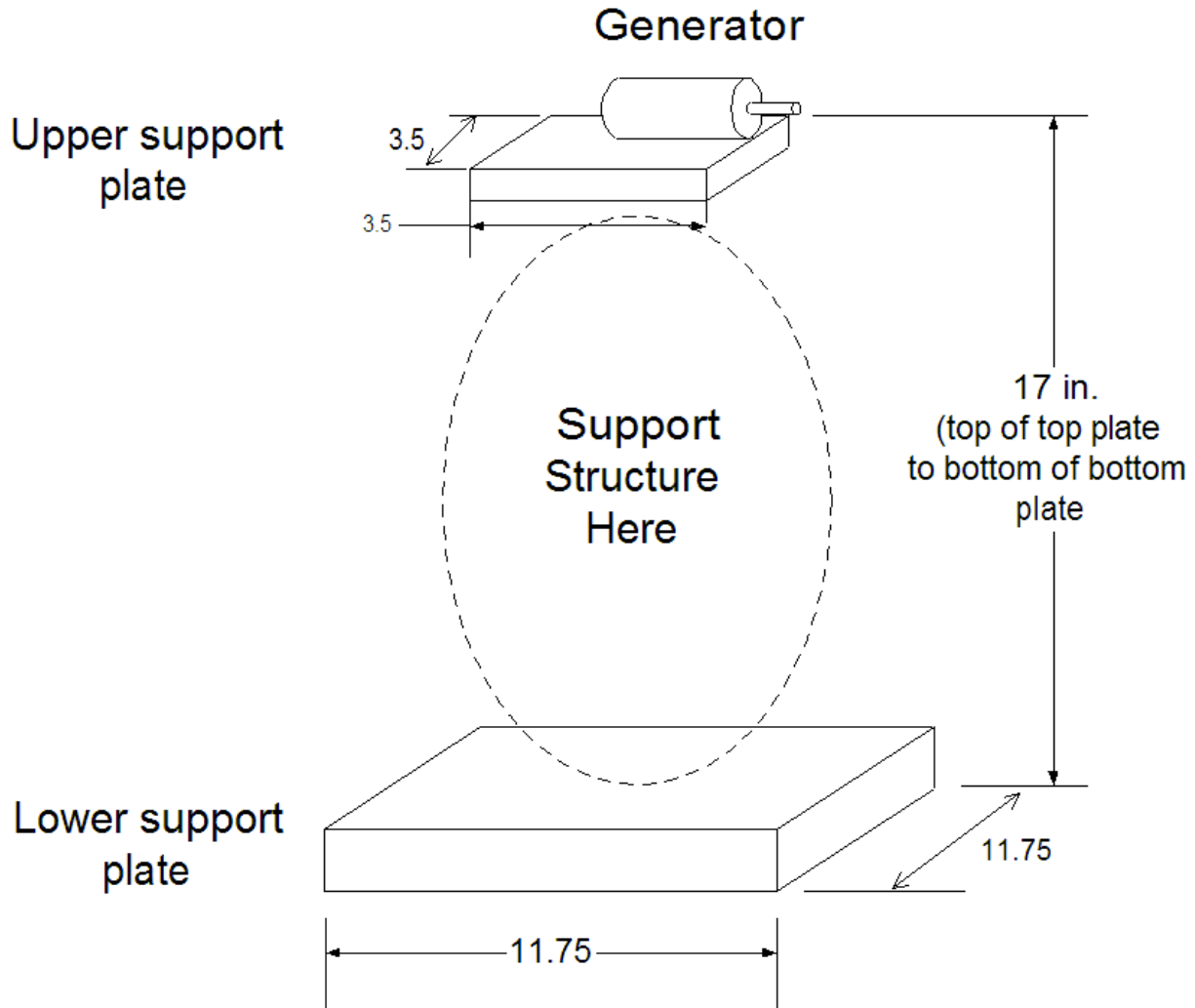


Figure 1. Schematic of Wind Turbine Tower Supports and Dimensions. The supporting structure for the wind turbine is to be constructed and attached between the upper and lower support plates as shown. The support plates are 0.75 inches thick pine or Douglas fir wood. The 17 in. separation distance must be maintained to within $\pm 1/16$ in. or points will be subtracted from your performance score. The support structure must not extend beyond the envelope defined by the base dimension of 11.75 x 11.75 in. over the 17 in. in height. The upper support plate sides must be nominally *parallel* to the lower support plate sides as depicted in the sketch. The support structure is to be attached to the upper and lower support plates by suitable means, however the support plates may not be otherwise modified.

See next page for guidelines on the presentation and writing the project report

Guidelines for the Project Presentation

- One presentation for your group. All group members should participate in the presentation
- A title slide that lists: the title of the project (descriptive and specific), the entity for which the presentation is being given, i.e., San José State University, Charles W. Davidson College of Engineering, E10 Introduction to Engineering, the names of the team members, the date of presentation.
- Several slides that clearly show and explain:
 - The design of your turbine blade (include your rationale for why you designed it as you did)
 - The design of your support tower (include your rationale for why you designed it as you did)
 - The performance of your wind turbine and support tower:
 - Power generated
 - Height, weight, and stiffness
 - Conclusions and Recommendations for Further Work (also include what you might have done differently knowing what you know now)

Guidelines for the Project Report

- One report for your group
- A title page listing: the title of the project (descriptive and specific), the entity for which the report was written, i.e., San José State University, Charles W. Davidson College of Engineering, E10 Introduction to Engineering, the names of the team members, the date of submission.
- A Summary section that succinctly and specifically states: what you did, how you did it, and what happened/what was learned. This section should consist of approximately three paragraphs, and be about one page long. A photograph that provides a good summary of your project is appropriate for this section.
- An Introduction section that describes what the project was all about, first in general (refer to this guideline to describe the general goals and requirements), but then *specifically*, presenting the *specific* objectives that your design addresses. This section should be at least one page long. Make sure that you include sufficient sketches, drawings, and/or photographs and verbiage to clearly explain to someone unfamiliar with your project what it is all about.
- A section that describes your design in DETAIL. This section should have figures (i.e., drawings, photos, sketches all with *annotation* (see p. 3-4 in <http://www.engr.sjsu.edu/bjfurman/courses/ME120/me120pdf/ME120labreportguide.pdf> for details on how to annotate figures) that document your design. You must have at LEAST an overall photograph, sketch, or drawing to describe your design. You will likely need more to document the turbine blades, the support structure, and the performance results. You will have achieved success in writing this section if a peer in the class could take what you have written, referring to it alone, and reproduce your device.
- A section that addresses the outcome of the project, such as how well it worked or didn't work, what you would do if you had more time to improve the design, what you learned, etc. Please be *specific* about the performance of your device and give *specific* recommendations for improvements or further work.
- A list of references used. Examples of how to cite references can be found in:
<http://www.lib.nus.edu.sg/lion/s/citeapa.html>
<http://www.lib.nus.edu.sg/lion/s/apastyle.ppt>
<http://www.engr.sjsu.edu/bjfurman/courses/ME120/me120pdf/ME120labreportguide.pdf>.
- Appendices with any other information that, in your judgment, might be a big help to someone trying to do a similar project (data sheets, catalog pages, etc.).