MAE 119 Homework 5
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Quiz 5 to be on Monday 5 March and will **cover wind power**

1. A wind turbine is designed with a 100 m diameter rotor, and can operate in a maximum wind-speed of 10 m/sec (i.e. the turbine will "feather" the blades so that no power is produced if the wind speed exceeds this value). What is the maximum possible power output of the turbine?

2. You have been asked to do a conceptual design layout of a wind farm intended to produce a maximum of 1000 MW of power. If the turbine described in problem 1 is the one to be considered for this wind farm, and you can extract a maximum of 1 MW of power per km^2 of land area (due to turbine-turbine interactions as well as effects of the turbines slowing down the wind), what is the spacing between turbines? How many turbines are required to meet the maximum design power? If the capacity factor of the site is 0.35, what will be the average power? Research the capital costs of wind turbines. What would this wind farm cost to install?

3. A wind turbine with 100 m diameter rotor has a wind cut-in speed of 3 m/sec and a cut-out speed of 10 m/sec. It is placed in a region where the wind speed has a uniform probability, f=0.1 for wind speed 0 < V < 10 m/sec, and f=0 for V>10 m/sec. What is the average power that this turbine produces? What is the maximum power it can produce (sometimes referred to as the rated power)? What is the capacity factor for this turbine?

4. Estimate the maximum wind power potential of the U.S. if 20% of the U.S. sites with wind power density exceeding 300 W/m^2 are used, and we are willing to suffer a 10% reduction in wind speed due to the placement of large arrays of wind turbines across the country. If all current U.S. electrical demand loads are constant, and we then replace 100 million of our automobile fleet with electric vehicles that each consume 10 kW-hr of electrical energy per day, what is the new U.S. electrical energy demand? What fraction of this demand can then be met with the wind turbine array deployment scenario outlined in problem 2?