Spring 2006 **EE 3120** Completion: Feb 15, 2006

Homework Set for Week 5

H5.1 - The generation capacity of the first 2 portions of the $125M Buffalo Ridge wind farm is 107 MW. There are 143 turbines. Each turbine is 750 kW, with a 157-ft diameter 3-blade design. The turbines need a minimum wind speed of 9 mph and will operate at speeds up to 65 mph. From lecture, the equation $P = KAV^3$ estimates the available power of the wind passing through the area that the blades rotate in. Of this power, an ideal wind turbine could extract 59.3%. If we include the losses due to non-ideal blade design, electrical and mechanical efficiencies, this drops to roughly 40%.

a) Fill in the table given:

Wind Speed (mph)	Wind Speed (ft/s)	P Available in Wind (Kw)	Ideal P_{GEN} (Kw)	Realistic P_{GEN} (Kw)
9				
20				
35				
65				

b) Assuming that 40% efficiency is correct for this wind generator, at what wind speed does the generator output its rated 750 Kw? Does 40% seem like a good estimate in this case?

c) Challenge question: At 65 mph, what is the force exerted on the top of the support tower? For this calculation, use the Ideal P_{GEN}. (If you don't calculate this correctly, the structural engineer will blame you when the tower collapses in a high wind).

H5.2 Peruse (read, study, go through examples) §6.2 of your text. Do problems 6.7 and 6.8. Goal is to to learn how air density varies with elevation (atmospheric pressure) and temperature. Knowing air density, you can then make the required design and performance calculations. This calculation is simplistic since it is based on "average" wind speed, but it does bring forth the main concepts.