Homework #5
ME 4470/ESE 4470/ME 5475
Wind and Tidal Energy

J. W. Naughton **Assigned: 11/15/15** **Due: 12/02/15**

This homework is worth 18 points.

1. (8) Provide references from reading the Executive Summary of "The Western Wind and Solar Integration Study Phase 2" to support your answers below (page number and line number).

   (a) What two views were used to consider the impact of cycling. Why?

   (b) What do the terms "starting", "ramping", and "cycling" mean in the context of electricity production?

   (c) How does most of the Western Interconnection market actually operate (or how are the sources of power chosen or dispatched)? How was the grid operated in this modeling effort?

   (d) How do the costs of cycling compare with the fuel cost reduction in the high wind and solar penetration cases?

   (e) Does high penetration solar or high penetration wind reduce CO2 emissions more?

   (f) What are reasons that wind and solar production would be curtailed (shut off even though they are capable of producing?

   (g) Summarize you overall understanding of how wind and solar will affect operation of coal and gas plants. Overall, his will this affect prices?

2. (10) We will again consider the wind turbine blade design we considered in homework 3. Here we will estimate the wind turbine power curve by coupling this turbine blade (actually 3 of them) to an induction generator through a gearbox. The output goal of this turbine is 425 kW. Torque and power information for the generator is provided below. Recall that the turbine was rotating at 30 rpm. However, the input to this generator must be 1800 rpm.

   (a) Repeat your blade element calculations for 4, 6, 8, 10, and 12 m/s. Determine the torque for each of these conditions.

   (b) Using these torque values, determine the power output from the generator assuming no losses in the bearings or gearbox (i.e. power is conserved through the transmission). Present your results as a wind turbine power curve.

   (c) If the wind speed got any higher, what would be the danger of continuing to allow the torque to the generator to increase? What could be done to ensure the generator still worked effectively at these higher wind speeds?

n/n_s	T kN-m	P kW
1.000	0.0	0
1.005	-0.5	-100
1.010	-1.0	-200
1.015	-1.5	-290
1.020	-2.0	-375
1.025	-2.5	-455
1.030	-2.8	-500
1.035	-3.0	-500
1.040	-2.8	-480