EE394J-10 Homework Assignment #2

Due date: 10/15/2012

For all questions elaborate some few conclusions or comments about the results. For all questions with simulations include a graph with the used model. State all the assumptions considered in the simulations. You are free to do as many assumptions you consider appropriate.

1) Let's compare the performance of wind turbines, spark ignition engines, and microturbines at different elevations. As a reference, consider that the atmospheric pressure in Miami (sea level) is 101 kPa and the atmospheric pressure in Denver (1600 m over sea level) is 83 kPa. You can assume that for the microturbine the pressure, P_2, at the output of the compressor is held constant regardless of the elevation. Likewise, some operational characteristics of the wind turbine such as wind speed are assumed to be equal regardless of the elevation. For the spark ignition engine consider that the compression is considered to be a reversible adiabatic (i.e. isentropic) process. Also, consider that the specific heat ratio of air+fuel γ remains unchanged at about 1.38 despite the change in temperature at different heights (you would need a more significant temperature difference in order to notice a difference in the specific heat ratio). For the microturbine, the spark ignition engine and the wind turbine plot relative efficiency vs. elevation. Which of the three DG technologies see its efficiency changing the most when comparing Denver and Miami?

Note #1: You will need to do some little research to find how air pressure, temperature and density change with elevation.

Note #2: Relative efficiency means that you need to assign a relative efficiency of 1 to the elevation where you expect to observe the maximum efficiency which will correspond to a given absolute efficiency which is, of course, less than 1.

2) Consider that you are using 20 Maxwell Boostcap BCAP2000 connected in series to provide energy to a 1 ohm resistive load. If at the initial time all capacitors are at their maximum voltage (2.7 V), how long will it take to discharge the capacitors to 50 % of their initial voltage? How long will it take to discharge them to 50 % of their energy? What is the maximum current during the discharge process? Is the maximum current of 4300 A exceeded? Now consider that you have a 5 kW constant-power load instead of the resistance with the same arrangement and initial voltage. Please, find v(t) and calculate what is the minimum discharge voltage with this load.

3) Consider that you are operating a MCFC with an output of 48 V. Suddenly, the load increases in 10 kW. The MCFC takes 5 minutes to be able to feed the extra load. If it is assumed that the current drawn by the new load of 10 kW is fixed (200 A) please propose some lead-acid battery (you may look in the Internet for telecom battery manufacturers) to use considering two cases: a) you don't allow the battery voltage to drop below 5 % of the battery nominal voltage at the end of the discharge. b) you don't allow the battery voltage to fall below its minimum voltage (1.75 V/cell). For each case, estimate the battery volume using the data provided in class.