1. Power system history:
   
a. (3 pts) **What was Samuel Insull's electric power industry insight and how did it lead to public utility commissions?**

   *It was his realization that the key to making money was to find ways to spread the high fixed costs of facilities over as many customers as possible.*

   *The risk of the monopoly alternative, of course, was that without customer choice, utilities could charge whatever they could get away with. To counter that criticism, he helped establish the concept of regulated monopolies with established franchise territories and prices controlled by public utility commissions (PUCs).*

b. (2 pts) **What led to the PURPA of 1978? How did the Act impact the renewable energy industry?**

   *With the country in shock from the OPEC oil crisis of 1973 and with the economies of scale associated with ever larger power plants having pretty much played out, the country was drawn toward energy efficiency, renewable energy systems, and new, small, inexpensive gas turbines. The Public Utility Regulatory Policies Act of 1978 (PURPA) was designed to encourage these systems promoting energy efficiency.*

c. (5 pts) **Explain the roles that "must run", "load-following", "peakers", and "renewable" power plants have in the power system. Give an example of each. Draw a picture to aid your explanation.**

   *Some plants, such as nuclear reactors, are designed to run continuously at close to full power; so they are sometimes described as **baseload** ("must-run") plants.*

   *The intermittency of renewables means they are normally allowed to run whenever the wind is blowing or the sun is shining since they have almost zero marginal costs.*

   *Most fossil-fueled plants and hydroelectric facilities can easily slowly ramp up and down to track the relatively smooth, predictable diurnal changes in load. These are **load-following** intermediate plants.*

   *Some small, cheap to build, but expensive to run, plants, sometimes referred to as **peakers**, are mostly used only a few tens of hours per year to meet the highest peak demands. Some plants are connected to the grid, but deliver no power until they are called upon, such as when another plant suddenly trips off line – referred to as **spinning reserves**.*
2. Consider a single 87.5 W, First Solar CdTe module used to charge a 12-V battery.

a. What duty cycle should be provided to a MPP, buck-boost converter to deliver 14-V to the battery when the module is working at standard test conditions (STC)?

1) (2 pts) What are the standard test conditions?

b. (5 pts) Suppose $T_{\text{amb}}$ is $25^\circ C$ with 1-sun insolation. Recalculate the amps delivered to the battery.