Automation of Energy Systems

Alberto Leva

18 February 2015

Reg. No. _____

Last name _____

Given name(s) _____

Signature _____

- Answer the questions in the spaces provided.
- If you run out of room for an answer, continue on the back of the page.
- Hand in *only* this booklet. No additional sheets will be accepted.
- Scoring also depends on clarity and order.

1. Consider an islanded electric generator with equivalent coordinated power and frequency control realised via a PID. Assume the generator to be described by a linear model with a gain of $20MW$, assuming a per-unit command, and a time constant of $10s$.

   (a) Draw the block diagram of the control system.

   (b) Tune the controller for a closed-loop settling time of $8s$.

(c) Interpret the result in terms of the classical primary/secondary scheme.

2. Consider a system in which a thermal capacity $C = 10^5 J/K$ is connected to a heater with maximum power $P_h = 10kW$ and a response to the per-unit command exhibiting a time constant $\tau_h = 5s$. Let an external temperature T_e act as a disturbance, $G = 20W/K$ being the corresponding heat loss conductance.

   (a) Set up, draw and tune a temperature control scheme for a closed-loop dominant time constant of $100s$.

   (b) Determine the maximum achievable over-temperature with respect to the external ambient and the maximum achievable temperature rate, and discuss the equipment sizing accordingly

(c) Discuss the opportunity of including a feedforward compensation for the external temperature disturbance.

3. Illustrate the “boiler follows” control scheme for electric generators, indicating and briefly motivating its advantages and disadvantages.

4. Explain how a modulating loop can be endowed with an on.off actuator, and how the envisaged solution is typically implemented and tuned.