Automation of Energy Systems

Alberto Leva

12 September 2019

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 electric network with two generators, both having

$$G_{1,2}(s) = \frac{P_n}{1 + s\tau},$$

as transfer function from the throttling command θ, in the range 0–1, to the variation ΔP_g of the generated power, with $P_n = 50\text{MW}$ and $\tau = 10\text{s}$.

(a) Draw the block diagram representing the two generators connected to the network.

(b) Setting the total inerta J to $1/(100\pi^2)$ and the nominal frequency f_o of the network to $50\,Hz$, determine the characteristic time constant T_A.

(c) Tune a power/frequency controller in the form of a PI for a settling time of $100s$ for the compound of the two generators.

(d) Convert the so obtained PI into a primary and a secondary controller expressed respectively as K_p and K_i/s, assuming symmetry also as for the generators' secondary contributions.

2. Consider a thermal system in which a body of capacity $C = 12$ kJ/°C is heated by a combustor burning fuel with calorific power $HH = 48$ MJ/kg, and having a combustion efficiency $\eta_c = 0.75$.The body releases heat through a thermal conductance $G = 50$ W/°C, to a prescribed external temperature T_e.

   (a) Draw an electric equivalent of the system.

   (b) Determine a linear regulator acting on the fuel flow rate w_f [kg/s] to control the body temperature T, so that the settling time of the response of the controlled variable to a set point step variation does not exceed 10 min.

3. List and briefly describe the major policies for the control of thermoelectric generator, indicating and comparing their major advantages and disadvantages.

4. Explain, with the need of convenient schemes if you deem it useful, what is meant for "daisy chain" actuation, with specific reference to its use in the control of thermal systems.