Automation of Energy Systems

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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 $P_n = 20\text{MW}$ and $\tau = 5\text{s}$. The overall network time constant T_A is 10s.

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

(b) Detemine the total inerta J.

(c) Tune a power/frequency controller in the form of a PI for a settling time of $50s$ for the compound of the two generators.

(d) Estimate (motivating your answer) a value for the desired settling time below which a PI-based structure would not be adequate.

2. Consider a thermal system in which a body of capacity $C = 20$ kJ/°C is heated by a combustor burning fuel with calorific power $HH = 50$ MJ/kg, and having a combustion efficiency η_c between 0.5 and 0.7.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, in the worst case, does not exceed 10 min.

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

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