



AUTOMATION OF ENERGY SYSTEMS

Alberto Leva

18 July 2014

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, and let the transfer function from the command θ , in the range 0–1, to the normalised variation δP_g of the generated power, be

$$g(s) = \frac{100}{1 + 10s}.$$

- (a) Draw the block diagram representing the generator connected to a local network of inertia J and nominal frequency $\omega_o = 100\pi$ r/s , determining J so that the equivalent time constant T_A equal 8 s .

(b) Tune a PI power/frequency controller for a phase margin of 50° .

(c) Determine (also approximately) the correspondingly obtained cutoff frequency.

- (d) Illustrate how the use of a PID instead of a PI would widen the solution possibilities for the previous points.

- 2. Consider a thermal system in which a body of mass $M = 100\text{ kg}$ and specific heat $c = 800\text{ J/kg}^\circ\text{C}$, is connected to a heater of maximum power $P_{max} = 5\text{ kW}$. The body disperses heat toward a fixed external temperature T_e through a thermal conductance $G = 200\text{ W/}^\circ\text{C}$, and is subject to a prescribed disturbance power P_d .

- (a) Draw an electric equivalent of the system.

- (b) Tune a PI(D) controller structure to regulate the body temperature T acting on the heater command u , in the range 0–1, guaranteeing a settling time not exceeding 15 *min* for a unit step variation of the set point.

- (c) Express the transfer function from the P_d to T in the presence of the synthesised controller.

3. Illustrate, possibly with the help of an example, how the problem of optimising the power generation distribution in AC network is stated and addressed, also evidencing the relationships between the above matter and tertiary control.

4. Explain what is meant for daisy-chaining actuation, illustrating the role and relevance of said scheme in the context of energy systems.