Automation of Energy Systems

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Reg. No. _____

Last name _____

Given name(s) _____

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- 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 three busses. Bus 1 is a generator one, bus 2 a PQ one, and bus 3 the slack one.
   (a) Draw the network scheme.

   (b) Write the load flow equations.

2. Consider a system in which a body of thermal capacity C is connected to a heater and a cooler, of maximum power P_h and P_c respectively. Suppose that both are described by first-order models having a command in the range 0–1 as input, and the released power as output; denote by τ_h and τ_c their time constants. Finally, let a disturbance be provided by variations of the temperature T_e of the external ambient, with which the body exchanges heat through a thermal conductance G.

   (a) Draw an electric equivalent of the system.

   (b) Draw a split range scheme to control the body temperature with a PI regulator, and possibly two filtering blocks cascaded to the actuators (if you introduce such blocks, provide a motivation).

(c) Tune the so obtained control structure for a settling time of τ_{set} in both the heating and the cooling case.

3. Explain the meaning and the role of “primary”, “secondary” and “tertiary” power/frequency control in electric networks.

4. Draw and briefly comment a daisy-chaining actuation scheme, synthetically illustrating its use.