FINAL Exam ***Autumn 2017***

Duration: **90** minutes

- It is advisable to take knowledge of the entire text before answering any question.

- Applicants must respect the used notation and specify in each case the question number.

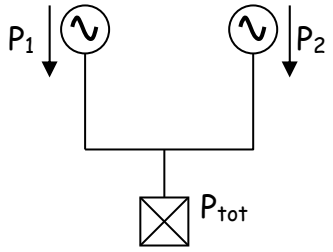
- Most attention will be given to the clarity of writing, presentation, the diagram and the presence of measurement unit

Results will be put in frames

Exercises are independent

Documentation: An A4 double face is authorized, Calculator authorized, phone forbidden

Exercise 1:



Consider a city powered by two power plants capable of delivering a total power of P_{tot}. The production cost of each power plant is given by:

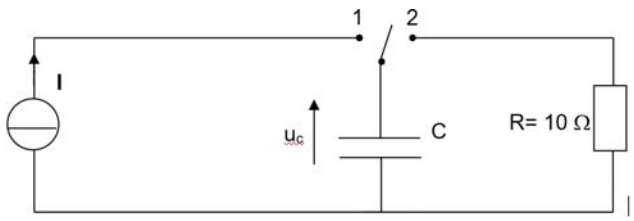
$C_1=10P_1+0.008P_1^2$ (€/hour with P_1 in MW)

$C_2=8P_2+0.009P_2^2$ (€/hour with P_2 in MW)

1) Give the total production cost function and the Hamiltonian function H.
2) Determine, as function of P_{tot}, the optimal values of P_1 and P_2 which minimize the total production cost (by solving the Hamilton canonical equations).
3) Determine, as function of P_{tot}, the incremental cost of each power plant and the production cost.

Exercise 2:

Supercapacitors (SCap) of C=3200F are used in the following application:



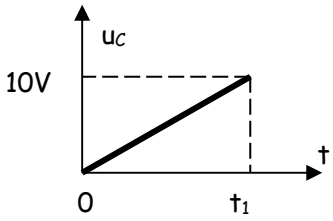


Fig 1. SCap Charge

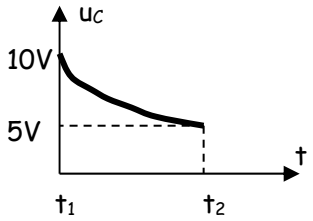


Fig 2. SCap discharge

In position 1 (from time 0 to t_1), the SCap are charged at constant current I = 200A, Fig.1 is obtained:

1) How many SCap are put in serial in this setup to form the total capacitance C.

2) Calculate the time t_1 corresponding to SCap voltage of 10V.

3) Calculate the energy $E_{received}$ stored in SCap during position 1.

In position 2 (from time t_1 to t_2), SCap are being discharged in the resistance R (Fig. 2). The discharge equation is of the form $u_C = Be^{-(t-t_1)/\tau}$

4) Determine the constants B, τ and t_2.

5) Calculate the energy (Er) dissipated as Joule effect in R.

6) Deduce the average power (Pr) dissipated as Joule effect in R.