ECSE 310 Thermodynamics of Computing, Winter 2019

Homework 5

Assigned: April 5, 2019

Due: 23:59 April 12, 2019

Submission instructions: Please submit your assignment online via MyCourses assignment tool prior to the deadline. If your submission is handwritten please provide a high quality image (preferably scanned using uPrint or similar). Poor quality digital photos may be rejected. Include any workings and calculations that you performed in completing the assignment.

Late policy: 1% deduction per hour

Academic integrity reminder: In submitting this assignment on MyCourses you are attesting that it is the result of your own work.

Each question has the same weight

1. Answer the following questions:
   a) Explain what drives entropy to increase and why?
   b) What's Landauer's principle?
   c) Does the Maxwell's demon violate the 2nd law of thermodynamics? If not, why?
   d) Explain the difference between fully reversible computing and adiabatic computing.

2. Consider a tape with N-bits, where 5 bits are repeated. What is the fuel tape value?

3. Describe how to realize NAND logic function with the Fredkin gate.

4. Assuming for typical transistors V_{dd} = 0.8 V, and they operate at 300 K. Calculate:
   a) If we are able to switch the transistors at Landauer's limit, then what's the capacitance we need to have? With this capacitance, what's the noise voltage V_n?
   b) Now let's assume that we set $V_{dd} = 5V_n$ in order to have less than 1 error in 1,000,000. In this case, what's the capacitance do we need to have? And what about switching energy now (write energy in both kT and J)?