Modeling and Analysis of Engineering Systems – SIMULINK Exercise 1

You should prepare your report as a single WORD document that contains the information in bold requested below. You must upload it to the class CANVAS site by 5:00 pm on the due date.

(1) The clothes iron described in class has a sole plate weighing 1.75 kg with an exposed area of 0.05 m^2. The sole plate is made of steel, which has a heat capacity of 450 J/kg·^oC, and the heat transfer coefficient for convection from the iron to the surrounding air (which is at 25 ^oC) is 20 J/s·m^2·^oC. The iron is rated at 150 W and is initially at the temperature of the air.

(a) Use SIMULINK to a plot of temperature of the iron versus time. Go out to 5000 seconds in time. **Submit the block diagram and the scope.**

(b) Using the plot, estimate the steady state temperature of the iron and the time needed for the iron to reach 100 ^oC. **Compare these to the values obtained analytically in class.**

(2) In class, we considered a problem in which a spherical metal pellet was dropped into a temperature bath in which the bath fluid was assumed to remain at a constant temperature T_f. Let us reexamine that problem by relaxing this assumption. Now, assume that there is no heat exchange between the bath and the surroundings but that the bath temperature can change due to heat released from the pellet. Now both the pellet temperature T(t) and the bath temperature $T_f(t)$ will vary with time. Take the initial pellet and bath temperatures to be 110 ^oC and 20 ^oC respectively, the mass m, surface area A and heat capacity C of the pellet to be 0.01 kg, 0.001 m^2 and 800 J/kg ^oC, and the heat transfer coefficient h to be 100 J/s m^2 ^oC. The mass m_f and heat capacity C_f of the bath are 0.08 kg and 4000 J/kg ^oC. The energy balance for the pellet is:

$$dT/dt = -(hA/MC)(T - T_f) \qquad T(0) = 110\ ^oC$$

And for the bath:

$$dT_f/dt = (hA/M_fC_f)(T - T_f) \qquad T_f(0) = 20\ ^oC$$

Simulate this system using SIMULINK. Plot T and T_f versus time on the same graph. What is the final equilibrium temperature of the system? **Submit your block diagram, the scope showing the results and your answer for the final equilibrium temperature**.

Now run one more case. Change the mass of the bath fluid from 0.08 kg to 10 kg. **Submit the resulting scope and comment on how this result is different from the first case.**