SHIRABE, Kei O.

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CS 131 FINALS – PROBLEM #3

[SLIGHT CODE MODIFICATION]

I added a bit of code to the original code so that it also prints out the graph of the function. I did not remove or modify any of the original code.

[DISCUSSION]

We are given this equation, which is the rate of change of a plate's temperature over time:

$$\frac{dT}{dt} = -\frac{A_s}{\rho V C_v}\left[\sigma_{SB}\varepsilon\left(T^4 - T_\infty^4\right) + h\left(T - T_\infty\right)\right]$$

Let's take a look at some of the constants in the equation:

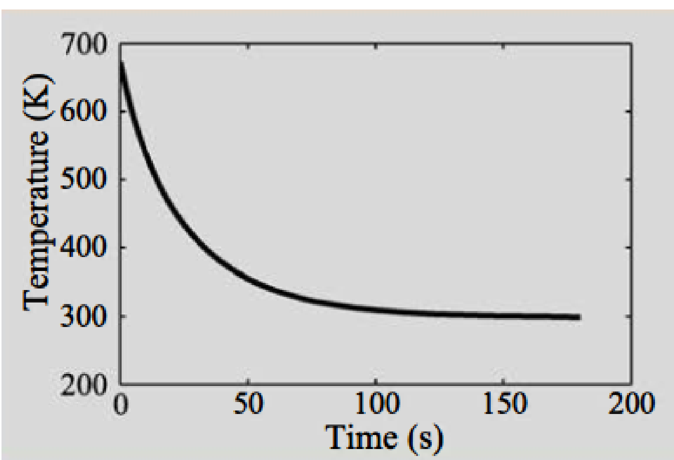
(a) Mass density – the mass per unit volume, most commonly denoted with the Greek letter ρ (rho). In this case, we are using kg/m^3 for our mass density
(b) Specific heat – (in physics) the heat (or energy) required to raise the temperature of the unit mass of a given substance (our plate) by a given amount (usually one degree of a temperature). Here our specific heat for our plate is given in J/kg/K where J is joules, and the temperature K is Kelvin
(c) Radiative emissivity – defined as the ratio of the energy radiated from a material's surface to that radiated from a blackbody (a perfect emitter) at the same temperature and wavelength. Since we are transferring heat, the emissivity is radiative.
(d) Stefan-Boltzmann constant – a physical constant dealing with blackbody radiation, and used in the Stefan-Boltzmann law. It is denoted with the Greek letter σ (sigma).
(e) Stefan and Boltzmann – these men were responsible for the Stefan-Boltzmann Law in blackbody radiation, which describes the energy flux emitted from a blackbody at temperature T. The law was actually deduced by Stefan and was later derived by

Boltzmann. Stefan then published the law in an article for the Vienna Academy of Sciences.

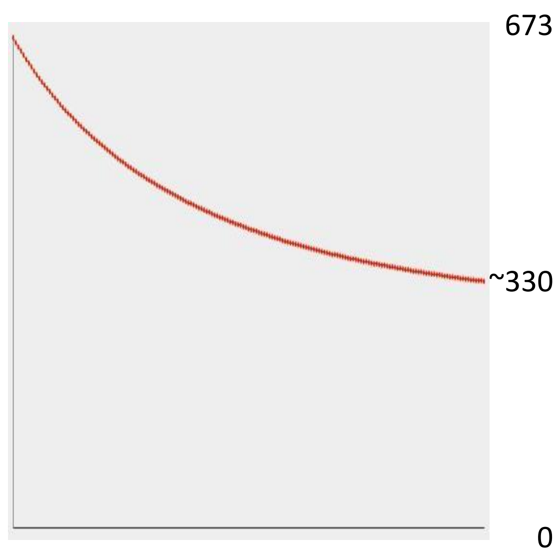
(f) Ambient temperature - I suppose T_∞ (T sub infinity) is a good symbol for ambient air temperature because we are dealing with blackbodies in our equation and these are ideal bodies, and usually ideal bodies have infinite something, whatever is called for in the equation.

So we run the RK4 code, with the equation input as (0.25/810)*((0.0000000567*0.8)*((y^4)-(298^4))+(30*(y-298))) along with all the other necessary variables, and we get the graph below, alongside the graph from the PDF.

GRAPH IN PDF:



GRAPH FROM RK4 CODE:



Note that the graph from the given PDF does not show K from 0 to 200 and the graph from the RK4 code shows K from 0 to 673, so while they may not look visually similar, the two graphs have quite similar data sets. The first graph does reach approximately 300 K much faster than the RK4 graph, and that is most likely due to the imperfections of the RK4 method, which does not actually follow the original graph but gets quite close to it.