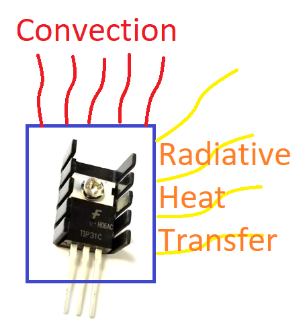
**Objective**: Linearize and simulate an energy balance model with radiative and convective heat transfer.



An energy balance equation includes convective and radiative heat transfer and is nonlinear because of the *T4* term.

Linearize the nonlinear differential equation by computing the partial derivatives γ and β with respect to the heater value (*Q*) and temperature (*T*). The γ and β are constants when evaluated at steady state conditions. The right hand side of the differential equation is a function *f(T,Q)* of only *Q* and *T* while the other values are constants.

**Condensed Linear Form**

with partial derivatives evaluated at steady state conditions ():

Use values:

* α=0.01
* Ta=23oC
* *m*=0.004 kg
* ε=0.9
* *A*=0.0012 m2
* cp=500 J/kg-K
* *U*=5 W/m2-K
* σ=5.67x10-8 W/m2-K4
* T∞=23 oC

to simulate the change in temperature over the 5 minutes when heater *Q* is adjusted to **75%**. Compare the simulated temperature response to data from the TCLab as well as the nonlinear model. Add the linear simulation prediction to the [solution from the prior TCLab exercise](http://apmonitor.com/pdc/index.php/Main/TCLabRadiative).

**Solution**