8.6.2 Example: Coffee cooling in a cup

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MO2.4 MO2.5

Recall the model equation for coffee cooling in a cup as given in Equation (8.40). By changing the state variable to be the difference in temperature between T_c and T_{out}, we can recover the linear scalar IVP of Equation (8.48). Define $T_{\text{diff}}(t) \equiv T_c(t) - T_{\text{out}}$. Note that,

$$\frac{\mathrm{d}T_{\text{diff}}}{\mathrm{d}t} = \frac{\mathrm{d}T_c}{\mathrm{d}t} \tag{8.51}$$

Then Equation (8.40) can be written as,

$$\frac{\mathrm{d}T_{\text{diff}}}{\mathrm{d}t} = -\frac{hA}{m_c c_c} T_{\text{diff}} \tag{8.52}$$

which is the form of the linear scalar IVP with $u = T_{\text{diff}}$ and $\lambda = -hA/(m_c c_c)$. Since $\lambda < 0$, then the temperature difference will decrease exponentially as t increases, i.e.

(8.53)

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