

#### **Introduction to Computational Science and Engineering**

<u>Help</u> sar

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**Course** 

**Progress** 

<u>Dates</u>

**Discussion** 

MO Index

☆ Course / 8 Initial Value Problems, Python Classes, ... / 8.6 Linear scalar IVP and expon...







Next >

**Discussions** 

All posts sorted by recent activity

## 8.6.2 Example: Coffee cooling in a cup

☐ Bookmark this page

Previous

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  $T_{\mathrm{out}}$ , we can recover the linear scalar IVP of Equation (8.48). Define  $T_{\mathrm{diff}}\left(t\right)\equiv T_c\left(t\right)-T_{\mathrm{out}}$ . Note that,

$$rac{\mathrm{d}T_{\mathrm{diff}}}{\mathrm{d}t} = rac{\mathrm{d}T_c}{\mathrm{d}t}$$

Then Equation (8.40) can be written as,

$$rac{\mathrm{d}T_{\mathrm{diff}}}{\mathrm{d}t} = -rac{hA}{m_c c_c}T_{\mathrm{diff}}$$
 (8.52)

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

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(8.51)

Previous

Next >

2/3

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