Lumped Capacitance

$$\frac{\theta}{\theta_i} = \frac{T - T_\infty}{T_i - T_\infty} = \exp\left(-\left(\frac{hA_s}{\rho V c}\right)t\right)$$

$$\tau = \frac{\rho V c}{hA_s} = RC$$

$$= \exp\left(\frac{-t}{\tau}\right)$$

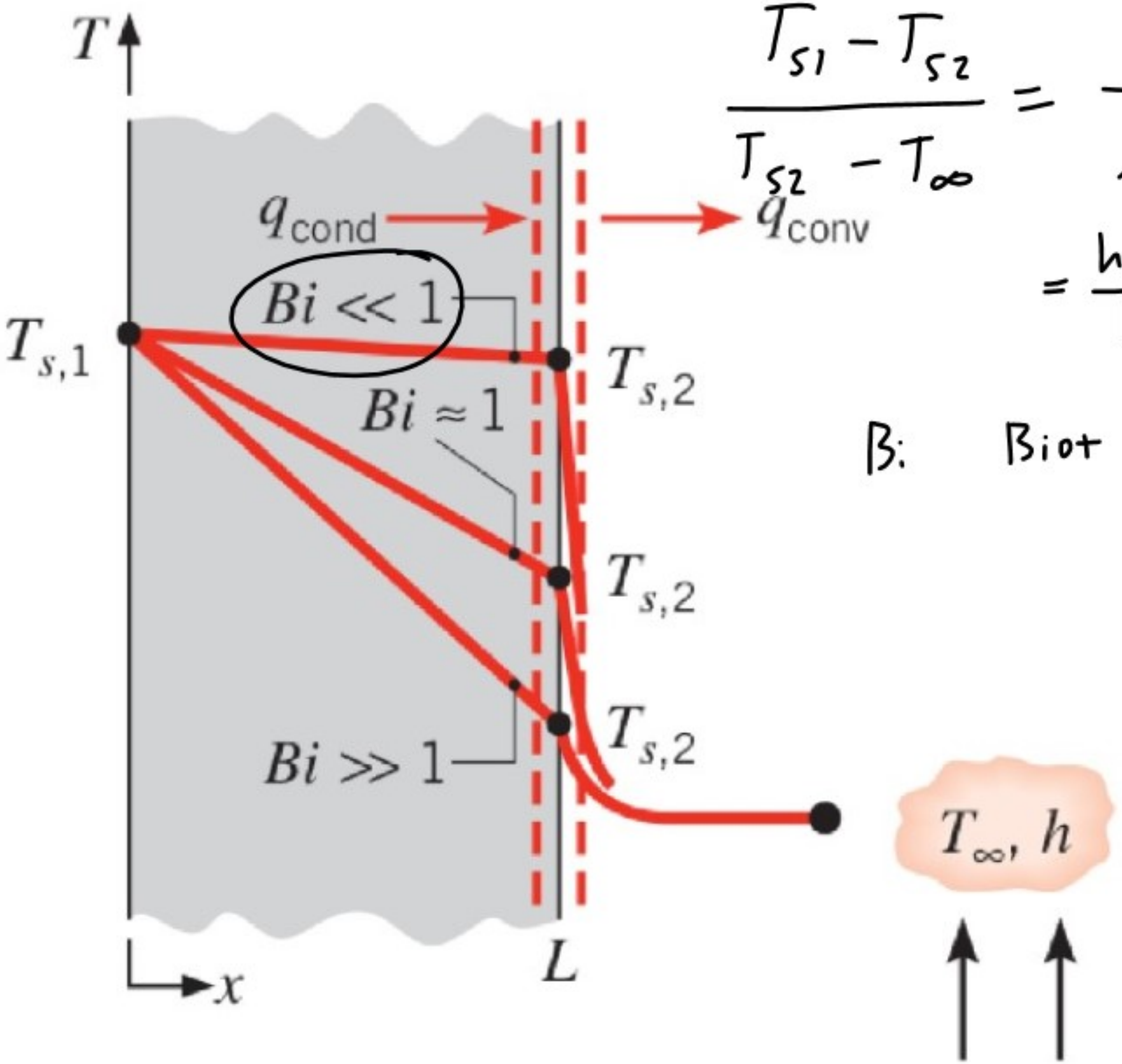
$$R = \frac{1}{hA_s} \qquad C = \rho V c$$

$$Q = \rho V c \, \theta_i \left(1 - \exp\left(\frac{-t}{\tau}\right)\right) = \Delta E$$

Validity

$$Bi = \frac{hL_c}{k} < 0.1$$

$$L_c = \frac{V}{A_s}$$



$$\frac{T_{s1} - T_{s2}}{T_{s2} - T_{\infty}} = \frac{L/kA}{1/hA} = \frac{R_{cond}}{R_{conv}}$$

$$= \frac{hL}{k} = Bi$$

Bi: Biot Number

General Solution

$$q_s'' A_s + \dot{E}_g - \left(h(T - T_\infty) + \varepsilon\sigma(T^4 - T_{sur}^4)\right) A_s = \rho V c \frac{dT}{dt}$$

See sec 5.3

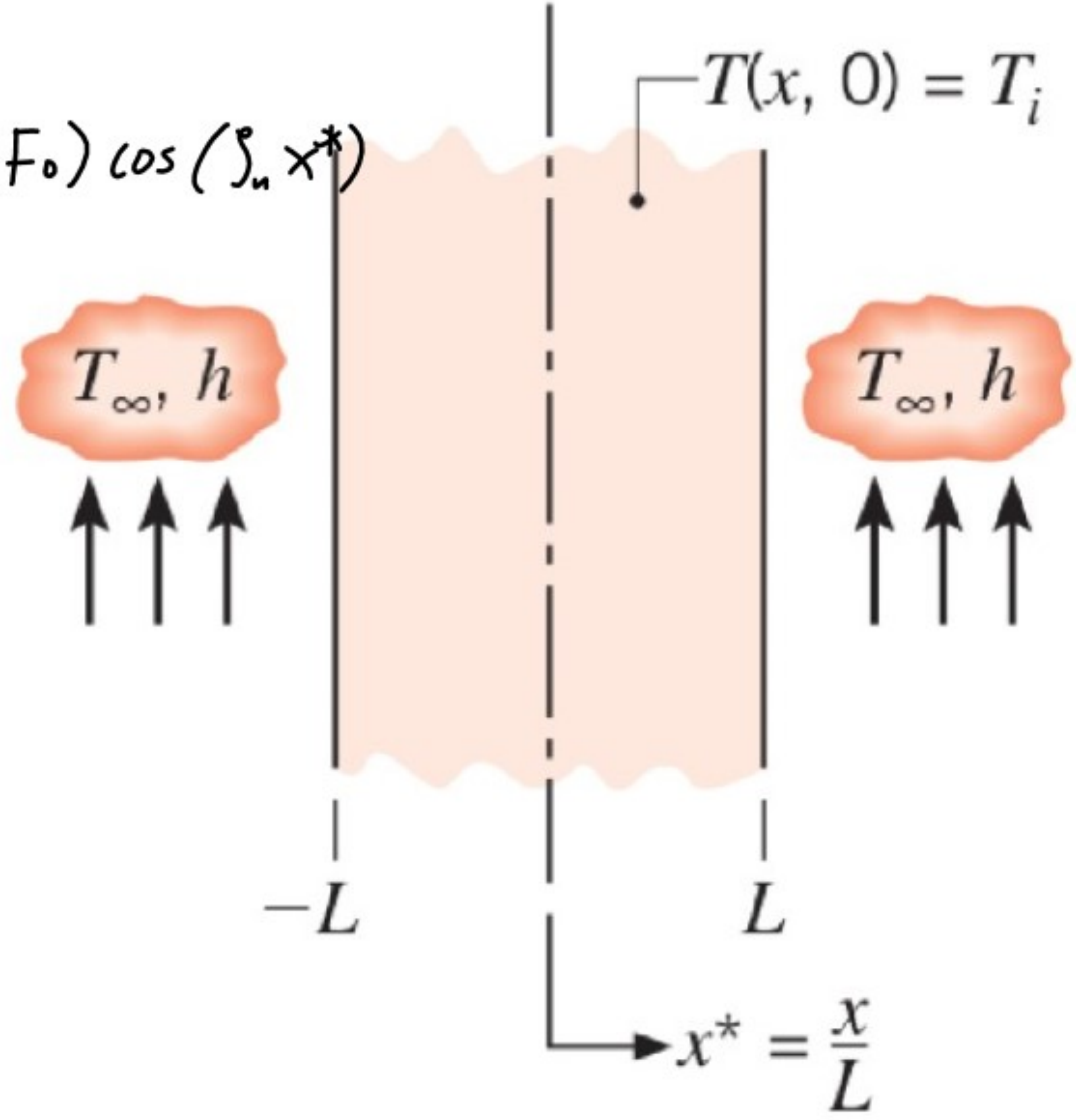
Spatial Effects

$$\theta^* = \sum_{n=1}^{\infty} C_n \exp(-\zeta_n^2 Fo) \cos(\zeta_n x^*)$$

$$C_n = \frac{4 \sin \zeta_n}{2\zeta_n + \sin 2\zeta_n}$$

$$\zeta_n \tan \zeta_n = Bi$$

Appendix B3



$$\theta^* = \frac{\theta}{\theta_i} = \frac{T - T_\infty}{T_i - T_\infty}$$

$$x^* = \frac{x}{L}$$

$$Fo = \frac{\alpha t}{L^2}$$ Fourier Number

Approximate Solution

$$\theta^* = C_1 \exp(-\zeta_1^2 F_o) \cos(\zeta_1 x^*)$$

Table 5.1