

6/16

Ch. 5

- LCM
- Semi-Infinite Solid (5.7)

$$T(x, T) \rightarrow \frac{\partial^2 T}{\partial x^2} = \frac{1}{\alpha} \frac{\partial T}{\partial t}$$

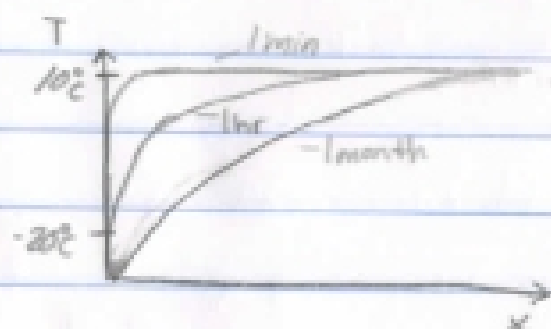
$$\alpha = \frac{k}{\rho c} \left[\frac{\text{m}^2}{\text{s}} \right]$$

 $T_{\infty} = -20^\circ\text{C}$
(wind)

B.C.
 $T_s = -20^\circ\text{C}$
soil

 $T_i = 10^\circ\text{C}$

Due 6/23/2014

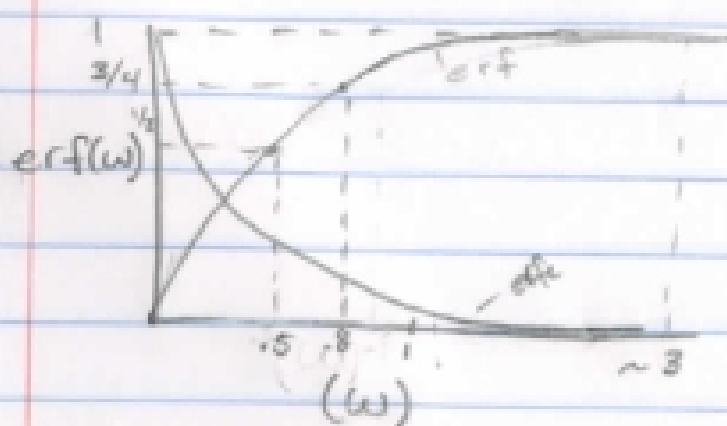
Plot $T(x, t_i)$ for soil in Toledo $t_i = 1 \text{ hr}$ $t_i = 1 \text{ day}$ $t_i = 1 \text{ month (30 days)}$ 

Use eqn 5.60

$$\frac{T(x, t) + 20^\circ\text{C}}{10^\circ\text{C} + 20^\circ\text{C}} = \text{erf} \left(\frac{x}{2\sqrt{\alpha t}} \right)$$

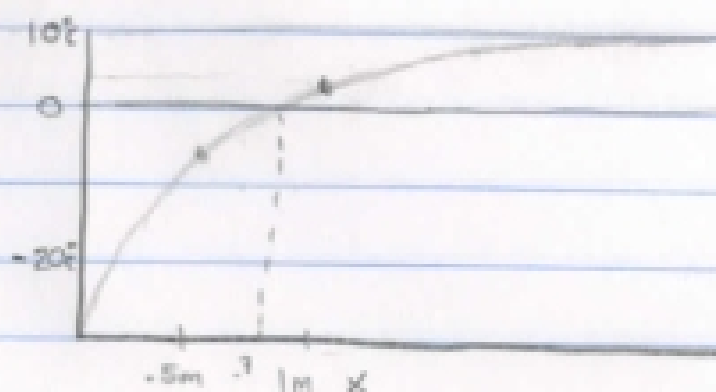
$$\alpha = \frac{k}{\rho c} = \frac{0.52 \frac{\text{W}}{\text{m}^\circ\text{C}}}{(2050 \frac{\text{kg}}{\text{m}^3})(1840 \frac{\text{J}}{\text{kg}^\circ\text{C}})} \rightarrow \alpha_{\text{soil}} = 1.37 \times 10^{-7} \frac{\text{m}^2}{\text{s}}$$

→ convert days / hours / month
to seconds



can do on excel, matlab, mathcad

$$t_3 = 2.5 \times 10^6 \text{ s (1 month)}$$



$$\frac{T(1\text{m}, 2.5 \times 10^6 \text{ s}) + 20^\circ\text{C}}{30^\circ\text{C}} = \text{erf} \left(\frac{1\text{m}}{2\sqrt{1.37 \times 10^{-7} \cdot 2.5 \times 10^6 \text{ s}}} \right)$$

$w \approx 0.88$

$$T(1\text{m}, 1\text{month}) = 3.4 \rightarrow \text{erf}(0.88) = 0.78 @ 1\text{m}$$

$$T(1\text{m}, 1\text{month}) = 6.7 \rightarrow \text{erf}(1.44) = 0.96 @ 0.5\text{m}$$