MODULE 2
LECTURE VI
JAN 2021
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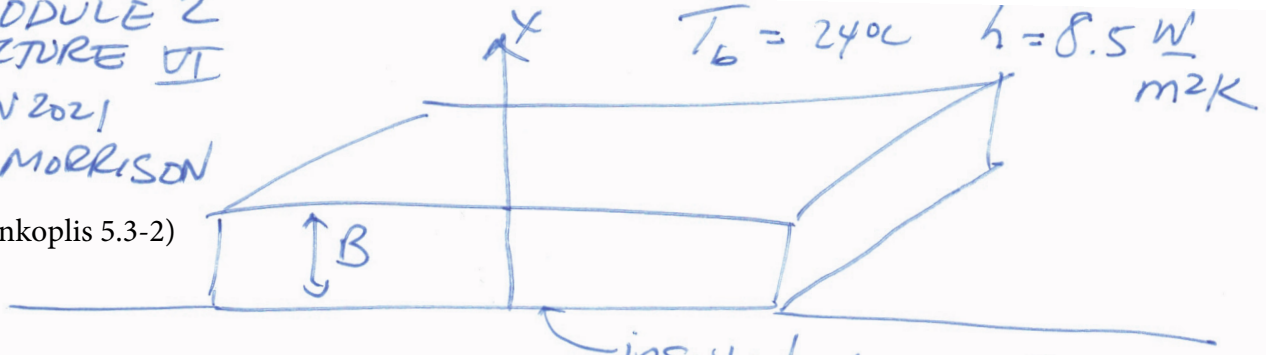
(Geankoplis 5.3-2)



1

$k = 0.197 \frac{W}{mK}$

$\hat{C}_p = 2.30 \frac{kJ}{kgK}$

$\rho = 998 \frac{kg}{m^3}$

$\alpha = \frac{k}{\rho C_p}$

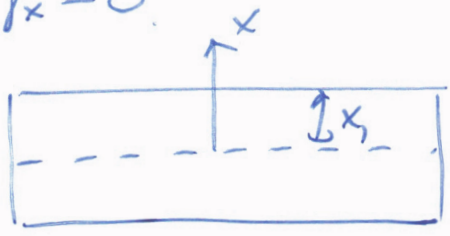
$= \frac{\left(0.197 \frac{W}{mK}\right) \frac{J}{Ws}}{\frac{998\ kg}{m^3} \cdot \frac{2300\ J}{kg\ K}}$

$B = 46\,mm \frac{m}{10^3 mm}$

$B = 46 \times 10^{-3}\ m$

$\alpha = 8.58238 \times 10^{-8} \frac{m^2}{s}$

★ We can use the Gurney + Lurie charts for a slab twice as thick. $x = 0$ has the correct BC, i.e. $q_x = 0$.



$x_1 = 46 \times 10^{-3}\ m$

$$Bi = \frac{hX_1}{k} = \frac{1}{m}$$

$$m = \frac{k}{hX_1} = \frac{0.197 \ \frac{W}{mK}}{\left(8.5 \ \frac{W}{m^2K}\right)\left(46 \times 10^{-3} \ m\right)}$$

$$\boxed{m = 0.50}$$

(a)

at center $n = \frac{x}{X_1} = 0$

5 hours: $Fo = \frac{\alpha t}{X_1^2}$

$$= \frac{\left(8.58238 \times 10^{-8} \ \frac{m^2}{s}\right)(5.3600 \ s)}{(46 \times 10^{-3} \ m)^2}$$

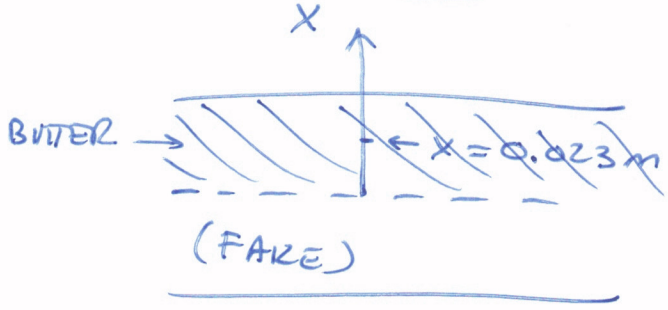
$$= 0.73$$

$$\frac{T_i - T}{T_i - T_0} = \frac{24 - T}{24 - 4.4} = 0.5$$

$$T = 14.2\,^{\circ}C$$

at surface $\boxed{T = 14\,^{\circ}C}$

(b) "middle of slab"



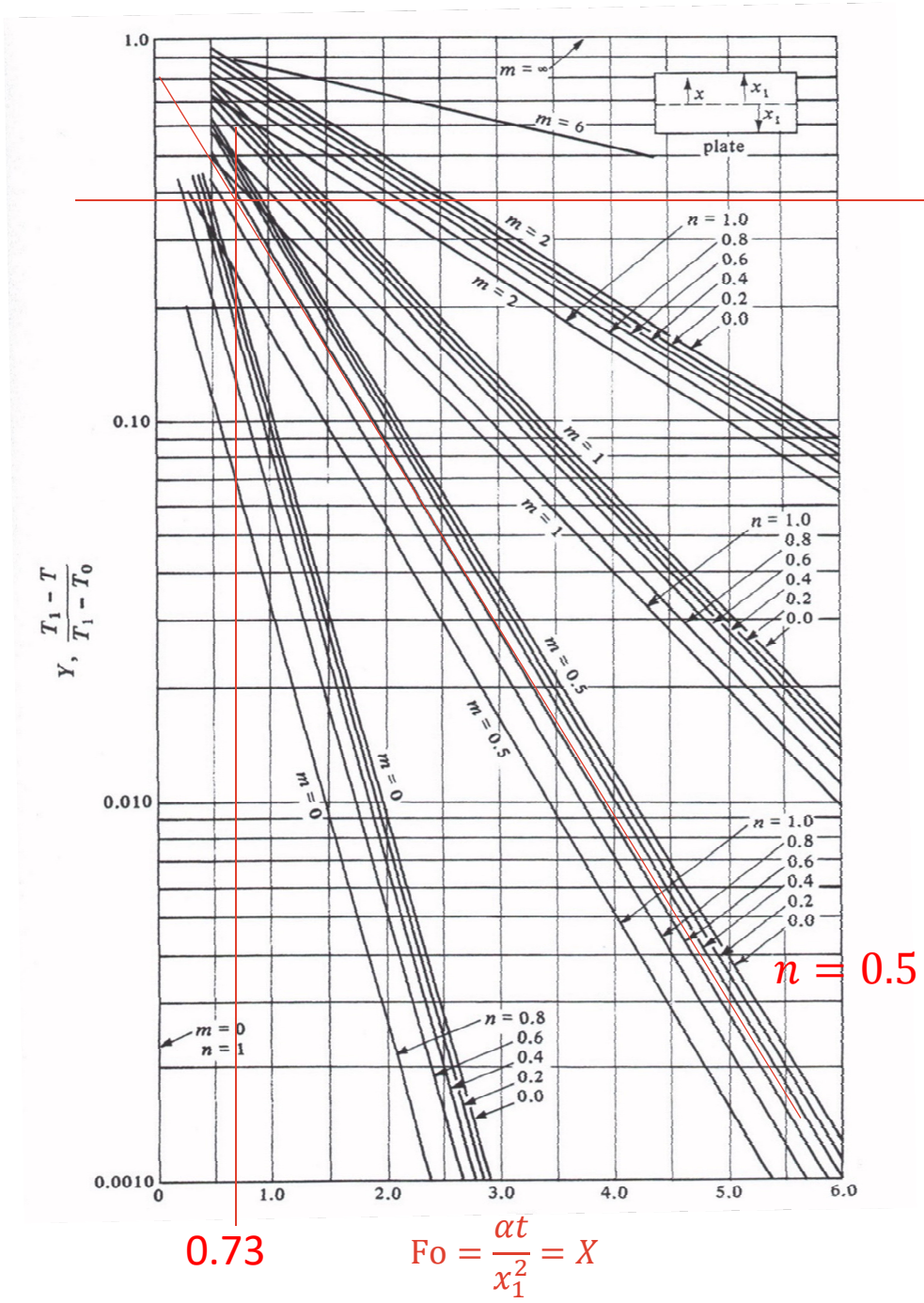
$$n = \frac{x}{x_1} = \frac{23\text{ mm}}{46\text{ mm}} = 0.5$$

$F_0 = 0.73$ (same)

$$\frac{T_i - T}{T_i - T_0} = \frac{24 - T}{24 - 4.4} = 0.38$$

$$T = 16.55$$

$\boxed{T = 17\,^{\circ}C}$



0.38

$n = 0.5$

0.73

$\text{Fo} = \frac{\alpha t}{x_1^2} = X$

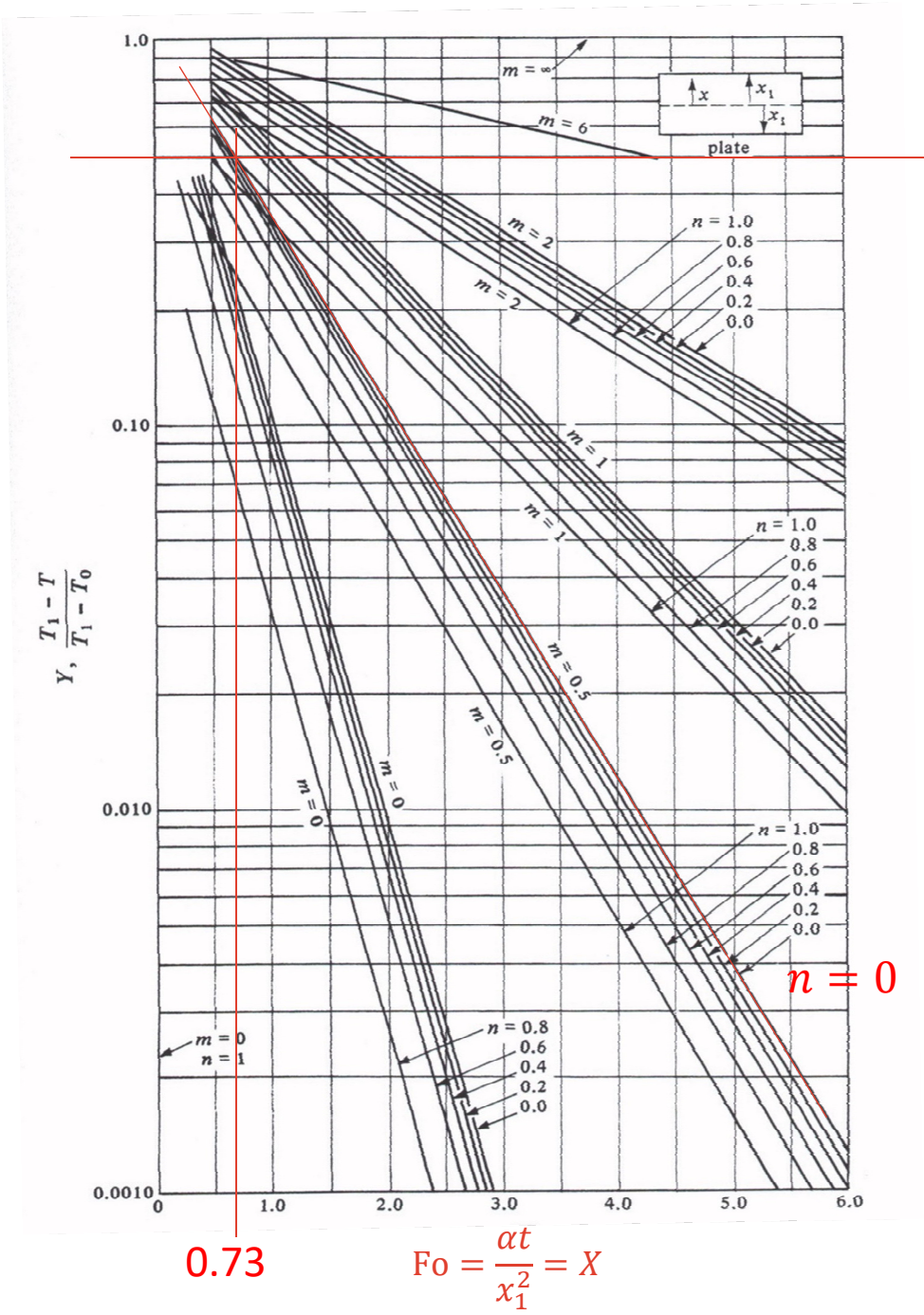
At the middle,

$x = 23mm$

$$\frac{T_1 - T}{T_1 - T_0} = 0.38$$

$$T = 17^o C$$

Ref: Geankoplis, 4th Ed, 2003



At the bottom, $x = 0$

$$\frac{T_1 - T}{T_1 - T_0} = 0.5$$

$$T = 14^o C$$

Ref: Geankoplis, 4th Ed, 2003