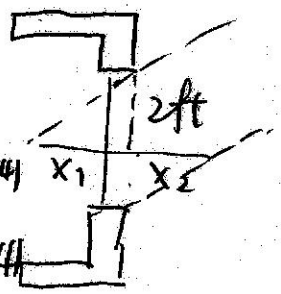
Problem 1: (4.1)

~~$\delta(d) =$~~ $\delta|_d = 0.41 \sin\left(\frac{2\pi}{365}(n-81)\right)$



solar noon: $\beta(0)|_d = \frac{\pi}{2} - \ell + \delta|_d = \frac{\pi}{3} + \delta|_d \Rightarrow$ $\beta(0)|_d \le \frac{\pi}{3} + 0.41$, $\beta(0)|_d \ge \frac{\pi}{3} - 0.41$

$$\Rightarrow \begin{cases} x_1 \ge \frac{2}{\tan(\beta(0)|_d)} \ge \frac{2}{\tan(\frac{\pi}{3} - 0.41)} \approx 2.7 \text{ ft} \\ x_2 \ge \frac{4}{\tan(\beta(0)|_d)} \ge \frac{4}{\tan(\frac{\pi}{3} - 0.41)} \approx 5.4 \text{ ft} \end{cases}$$

Problem 2: (4.3)

(a)

June Solstice: $n = 172$.

$\delta|_{d=172} = 0.41 \sin\left(\frac{2\pi}{365}(172 - 81)\right) \approx 0.41$ radians

$\beta(0)|_{d=172} = \frac{\pi}{2} - 0.697 + 0.41 \approx 1.28$ radians

$\Rightarrow P \ge \frac{8}{\tan(1.28)} \approx 2.37$ ft.

(b)

Winter solstice:

$\delta|_d = -0.41$

$\beta(0)|_d = \frac{\pi}{2} - 0.697 - 0.41 = 0.463 \Rightarrow Y = 2.37 \cdot \tan(0.463)$

$= 1.183$ ft

(c) skip part c

Problem 3 (4.4)

From Jan to Nov, see attached pic.

Problem 4 (4.5)

(a) $d = 172$

$\delta|_{d=172} = 0.41$ radians

$\beta(\theta)|_{d=172} = \sin^{-1}\left[\cos 0.558 \cdot \cos 0.41 \cdot \cos\frac{\pi}{12} + \sin 0.558 \cdot \sin 0.41\right] = 1.296$ radians

(b) $\Rightarrow \begin{cases} \text{height of tree} = 30 \cdot \tan 1.296 = 106.56 \text{ ft} \\ \phi_{tree} = \frac{\pi}{12} \text{ radians east of south.} \end{cases}$

(c) skip this part

Problem 5 (4.6)

this is a totally math problem, we won't cover it in exam. skip this problem

Problem (4.7)

for $d = 172$

a. ~~it is the angle~~ the azimuth angle of sunrise relative to due south = hour angle of sunrise

$$K+|_{d=172} = \cos^{-1}(-\tan 0.83 \cdot \tan 0.41) = 2.066 \text{ radians}$$

b $12{:}00 - \frac{2.066}{\pi/12} = 4{:}06$ a.m. solar time

C: Sunrise : actual time · (4:11 a.m.)

Problem 7 (4.8)

(a) $K+|_{d=172} = (12{:}00 - 4{:}11) \cdot \frac{\pi}{12}$

$$= \left[12 - \left(4 + \frac{11}{60}\right)\right] \cdot \frac{\pi}{12} = 2.045 \text{ radians}$$

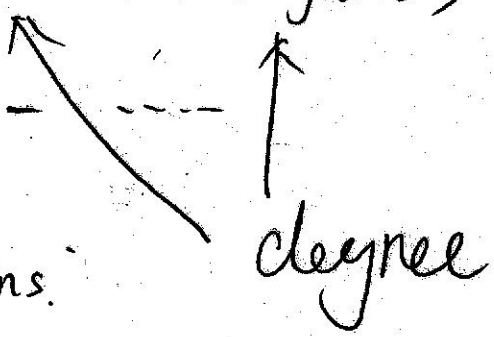
$K-|_{d=172} = (12{:}00 - 20{:}11) \cdot \frac{\pi}{12} = -2.141$ radians.

then, clock time for solar noon is $\frac{4{:}11 + 20{:}11}{2} = 12{:}11$ a.m.

(2) solar noon − noon = 12:00 − 12:11 = −11 mins

= eld + 4(local time − (median − local longitude))

= −1.5 + 4(◉ (−120°))



d=172 $b_{172} = \frac{2\pi}{364}(172-81) = 1.57$ radians.

$e_{172} = -1.5$

local ◉ longitude 122.375° W

(3) since

as tan 2.0453 = ◉ (−tan ℓ · tan 0.41)

⇓

ℓ = 0.81 radians

Problem 8 (4.9)

$\alpha = 0.7$ radians

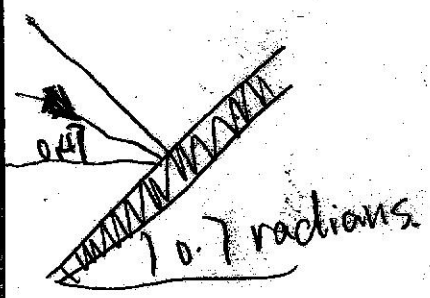
$\delta|_{d=1} = 0.41 \sin\left(\frac{2\pi}{365}(1-81)\right) \approx -0.40$

$\beta(0)|_{d=1} = \frac{\pi}{2} - 0.7 + (-0.40) = 0.47$ radians

$\Rightarrow \cos(\xi(0)|_{d1}) = \cos(0.47)\cos(0-0)\sin 0.7$

$+ \sin(0.41)\cdot\cos 0.7$

$\Rightarrow \xi(0)|_{d1} = 0.4$ radians



$a|_{d=1} = 1.160 + 25\sin\left(\frac{360}{365}(1-275)\right) \approx 1107$ W/m²

$k|_{d=1} = 0.174 + 0.035\sin\left(\frac{360}{365}(1-81)\right) \approx 0.152$

$r(0)|_{d=1} = \sqrt{[708\times 0.453]^2 + 147} - 708\times 0.453$

$= 2.20$

$\Rightarrow i_b(0)|_{d=1} = 1107\, e^{-2.20\times 0.152} \approx 792 \frac{W}{m^2}$

$i_{bR}(0)|_{d=1} = 792\cdot\cos 0.4 = 729 \frac{W}{m^2}$