HW#3 ⇒ Due Thursday Jan 31st 8pm

- Submit on CCLE
  Assignment: HW3
- 1 script + 1 published PDF / problem

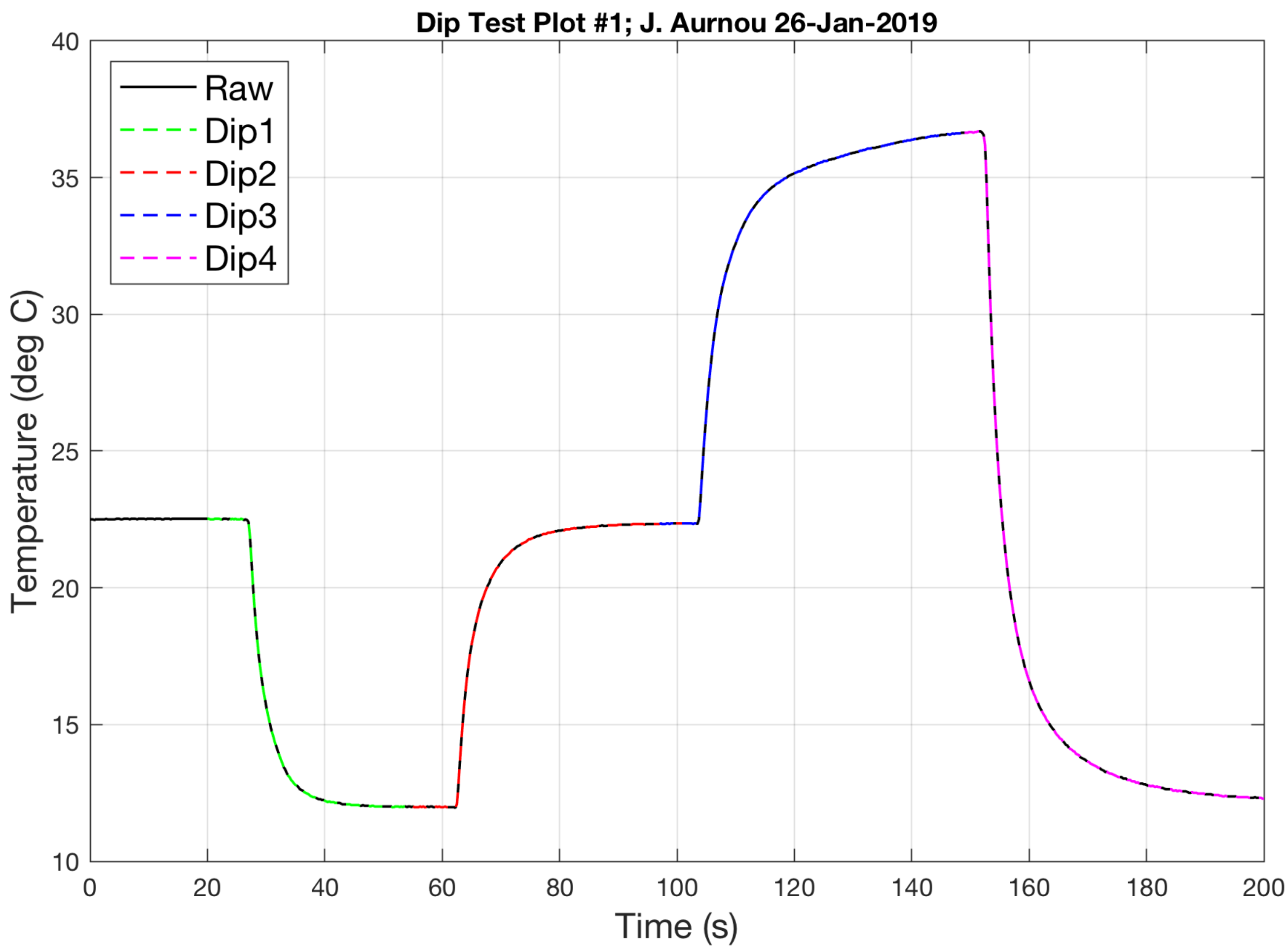
Prob# 1 Generalized Dip

- Plot Raw Dip Data (#1)
  - → DipTest_InClass.txt
    - → 1st Import into Matlab (uiimport)
- Define each dip event
  - Start with at least 1 second of data before the dip and let it go until the Temp. re-equilibrates.

- Write separate arrays for each dip event.

- <u>Overplot</u> each 'dip event' in its own color.

  → Use this same color scheme in following two dip plots below.



- In class we showed that

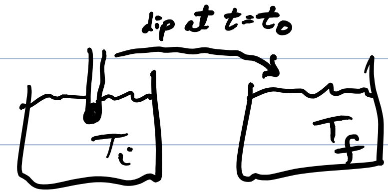
$$T(t) = T_C + (T_H - T_C)\exp\left(-\frac{(t-t_0)}{\tau}\right)$$

- But more generally, we have

$$T(t) = T_f + (T_i - T_f)\exp\left(-\frac{t-t_0}{\tau}\right)$$

where T_f is the final temp (post dip bath temp)
and T_i is the initial temp (pre-dip bath temp)

- Does not matter which bath is hotter/colder...

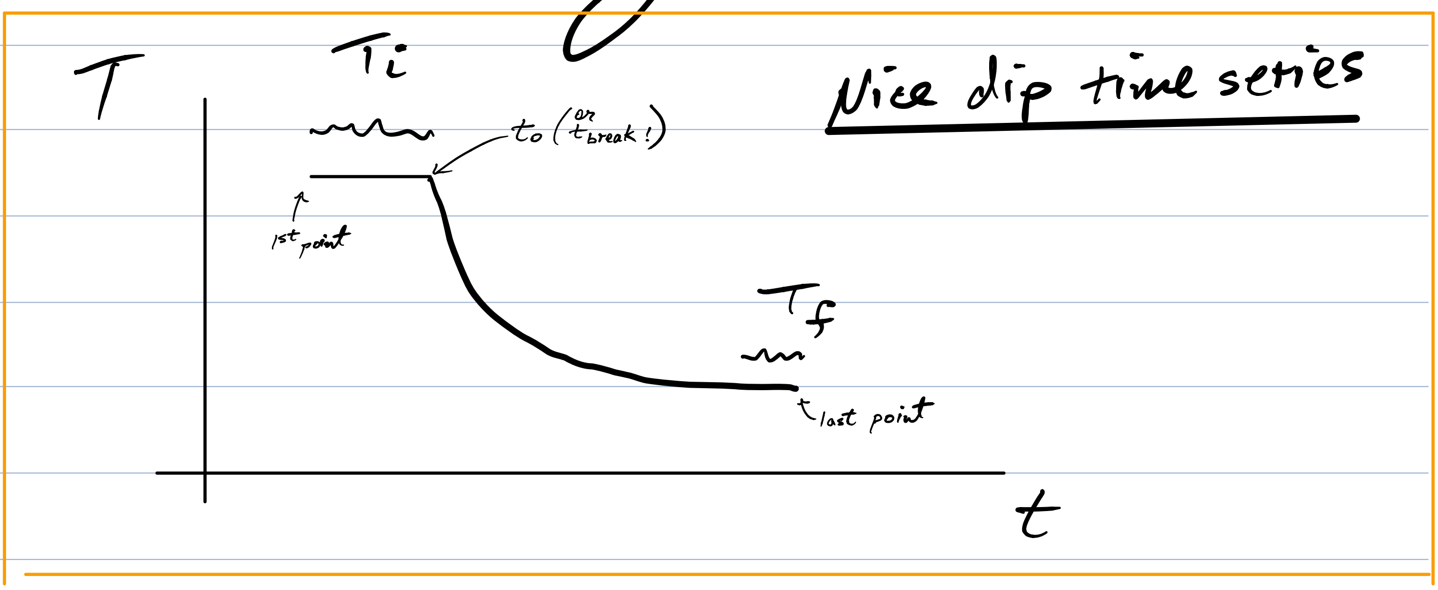


Based on the above equation, one can

- $\underline{\underline{\text{Define}}}$ $P(t) = \dfrac{T(t) - T_f}{T_i - T_f}$

  - Pick/define T_i & T_f arrays
    ↳ I had to pick the Dip3 values 'by hand'

- If you have created good dip arrays AND the data/experiment is good:
  - T_i will be well described by the first point in the array
  - T_f will be the last point in the array



- If it's not a good dip time series array, then do your best!...

→ Best fit each dip

↳ Define a Composite function:

$$P = \begin{cases} 1 & t < t_b \\ \exp\left(-\frac{t - t_b}{\tau}\right) & t \geq t_b \end{cases}$$

↳ t_b = the break point when the dip event occurs

↳ Use Nlinfit to find (t_b, τ)

Nlinfit example script + Notes files on CCLE ↳ HW3

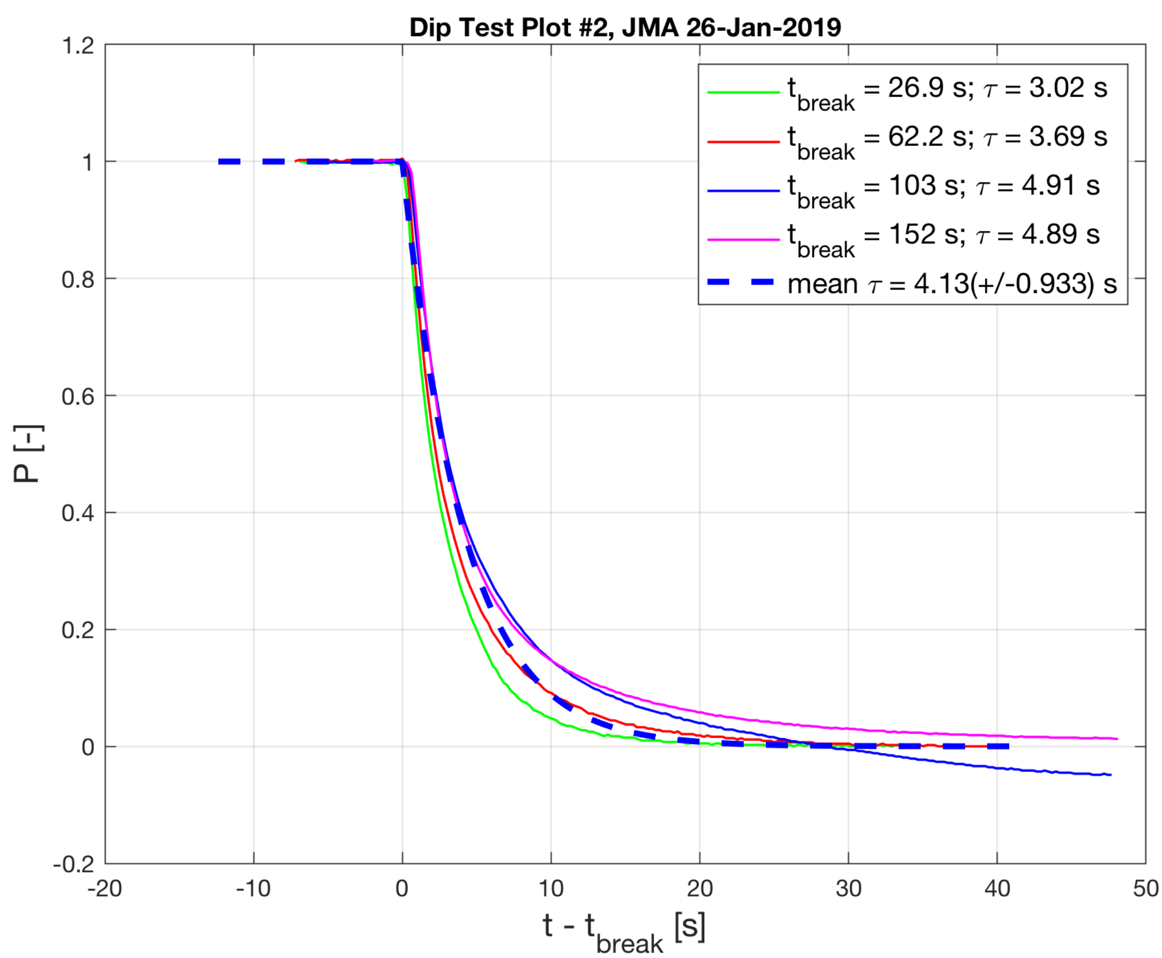
↳ Calc + report

mean(τ_i) ± std.dev(τ_i)

(#2)

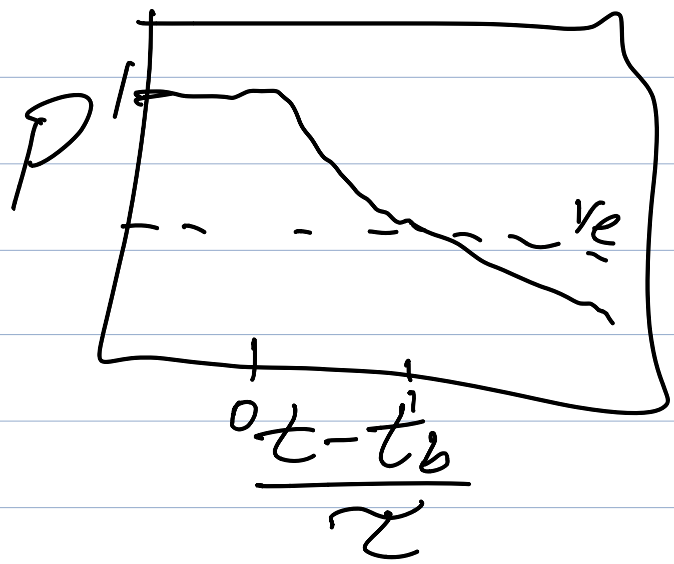
↳ Plot all the dips w/ their different colors on a single plot, P vs. ($t - t_b$)

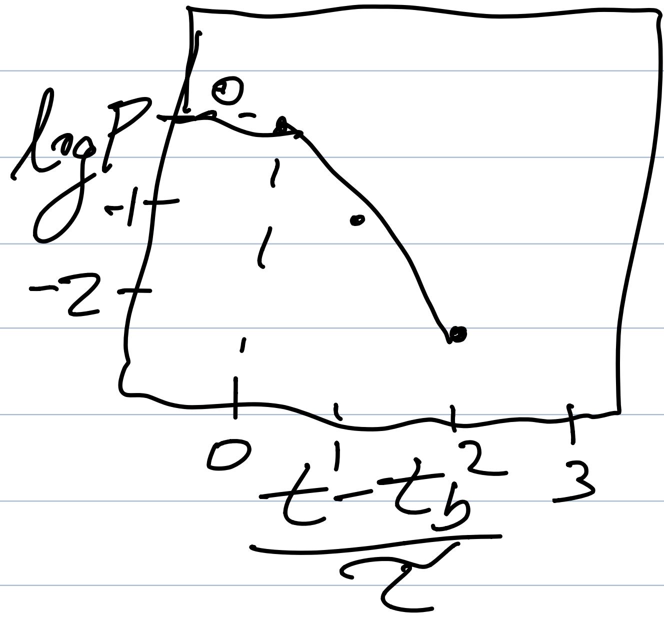
↳ Overplot theory using mean(τ)

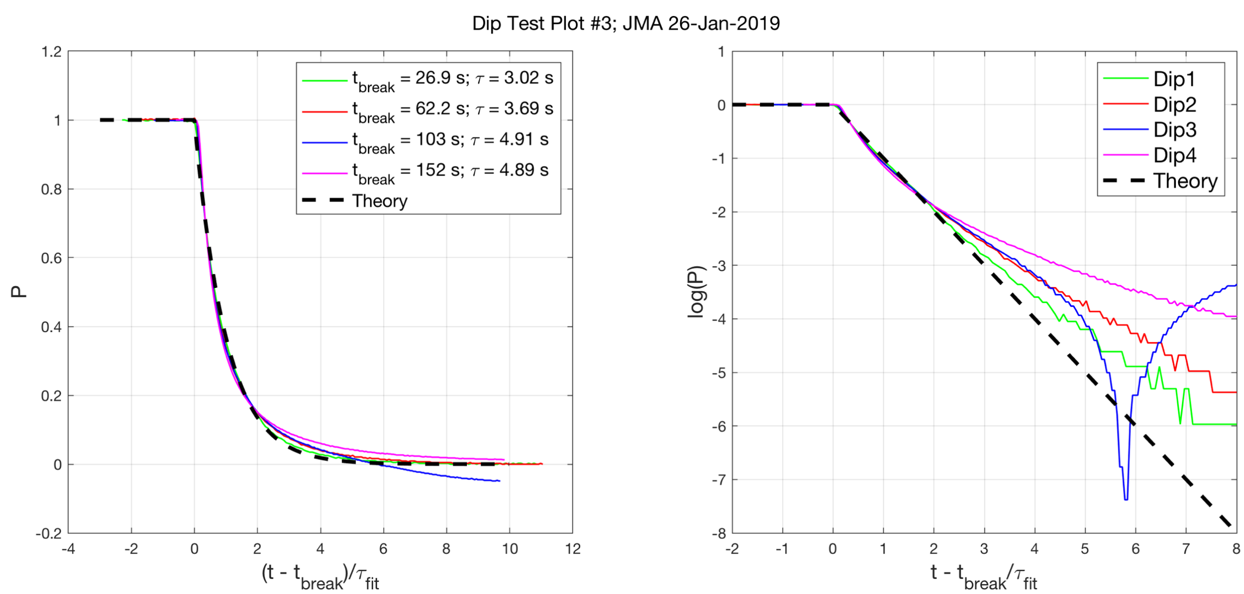


↳ Subplot (#3)

Show all the dips & the best fit τ curve







Prob # 2

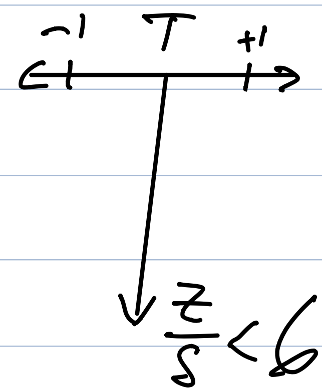
$T(0,t) = \cos \omega t$;

$K = 10^{-6} \frac{m^2}{s}$; $\omega = 2\times 10^{-6} \frac{rad}{s}$

- Plot $T(z,t)$ vs z/δ at every time in array t.

$t = 0:(\tau/20):\tau$

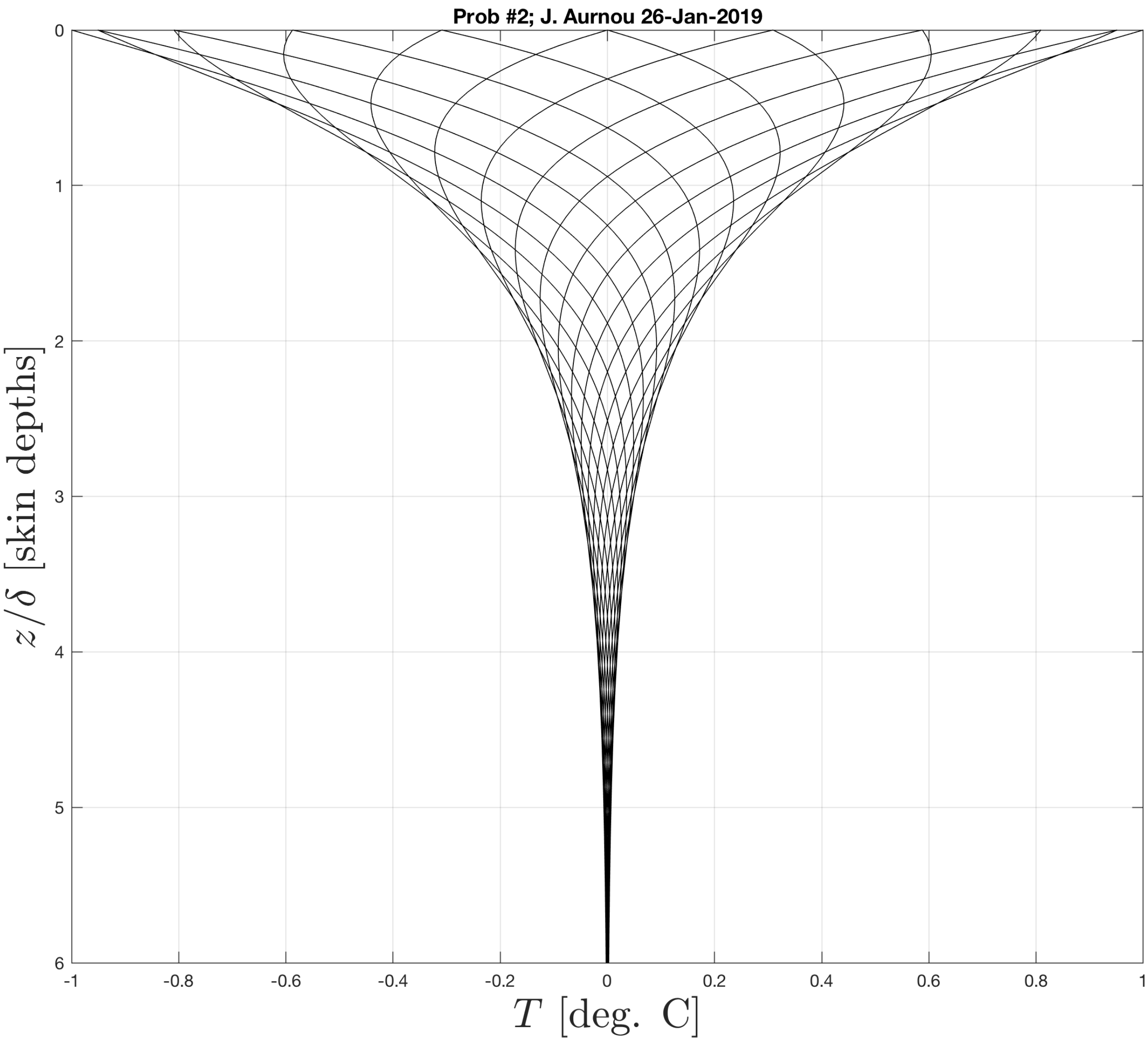
$z = 0:(\delta/20):6\delta$



- To do the above, first calculate $T(t,z)$ at a 2D Matrix
- with time varying along 'x' (along rows)
- and depth z varying in 'y' (along columns)

- Carry out $T(z,t)$ calculation using 2D Array Operations
  - ↳ I used meshgrid (Gilat 10.2) to make 2D arrays of t & z, called tt & zz
  - Then T(tt, zz) can be calculated in a single step
    - ↳ Partial credit if T-matrix created via loops

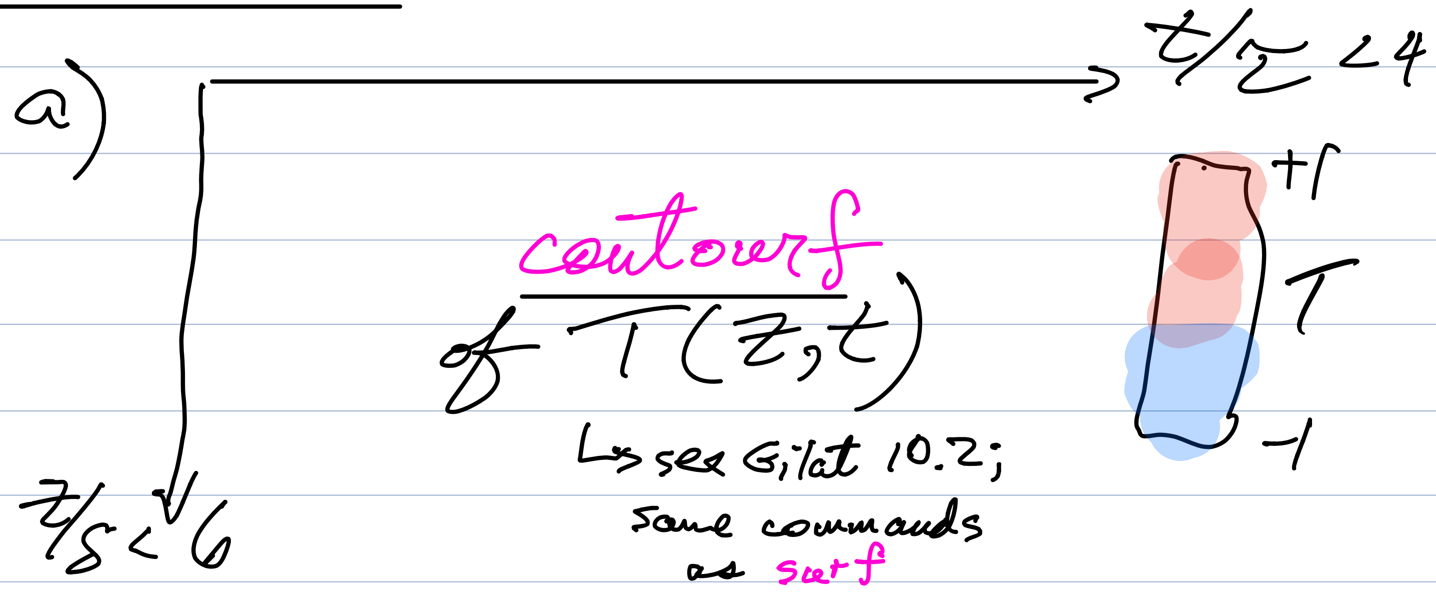
- Save all essential arrays/info in 'Prob2.mat'


Prob #2; J. Aurnou 26-Jan-2019
0
1
2
3
4
5
6
z/δ [skin depths]
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
T [deg. C]

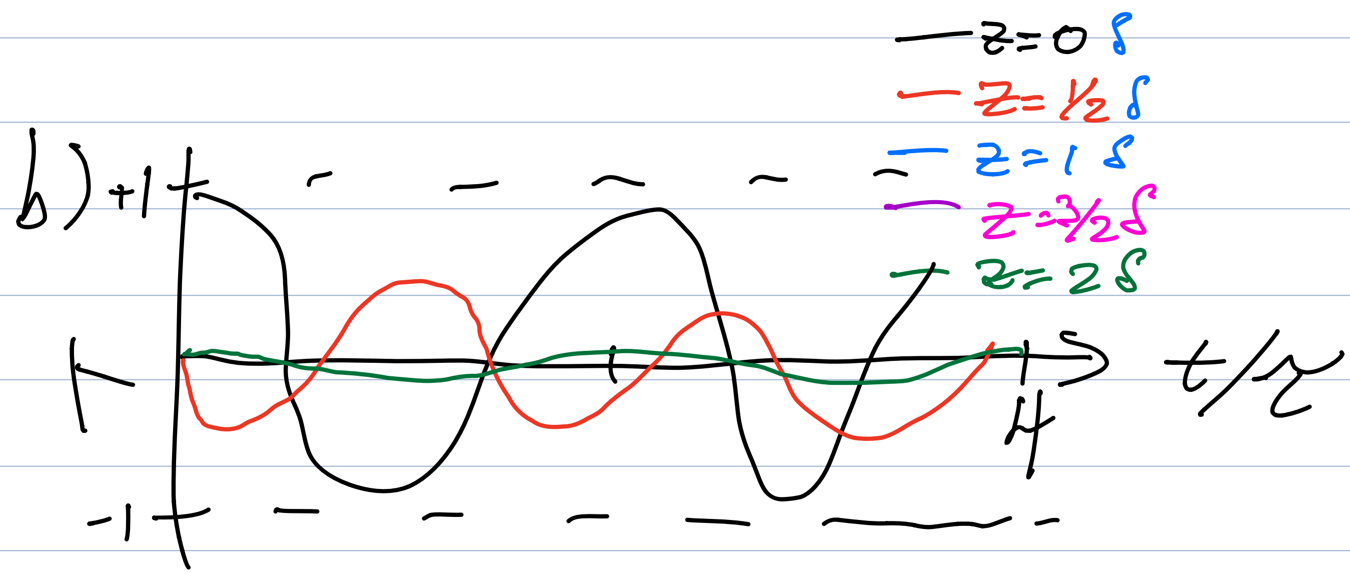
Prob #3

Problem #2 set-up, but now make the plots below.

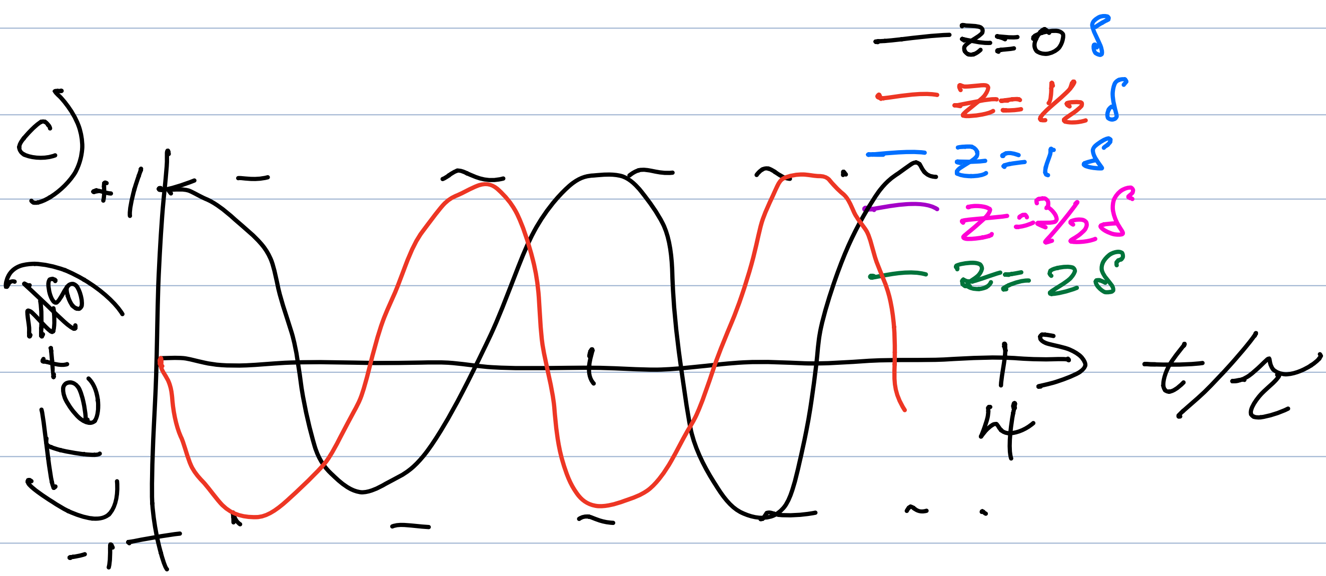
a)



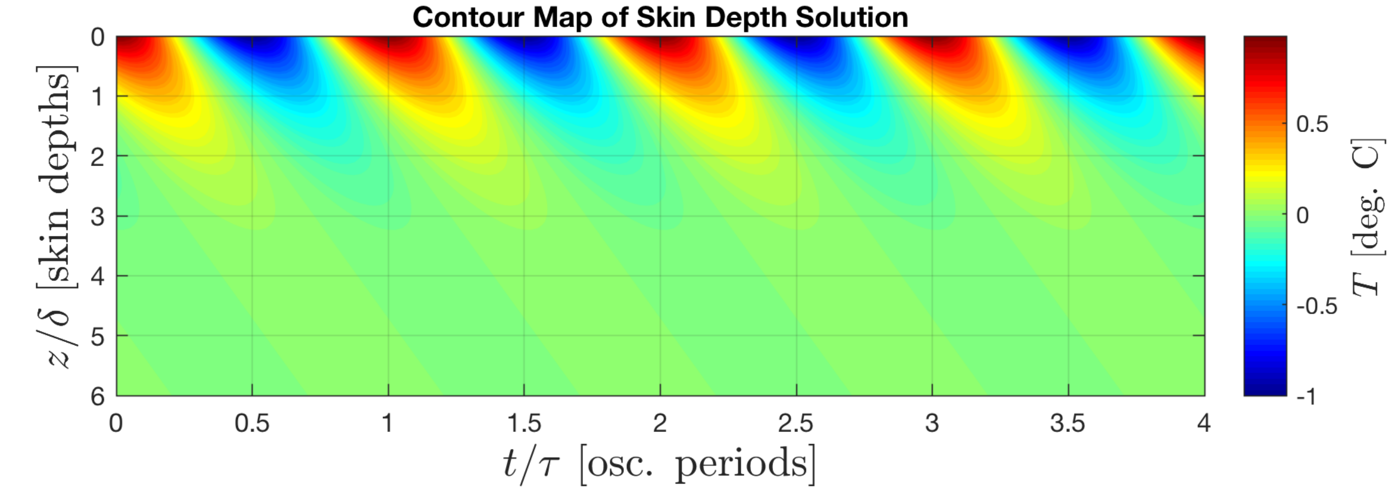
b)

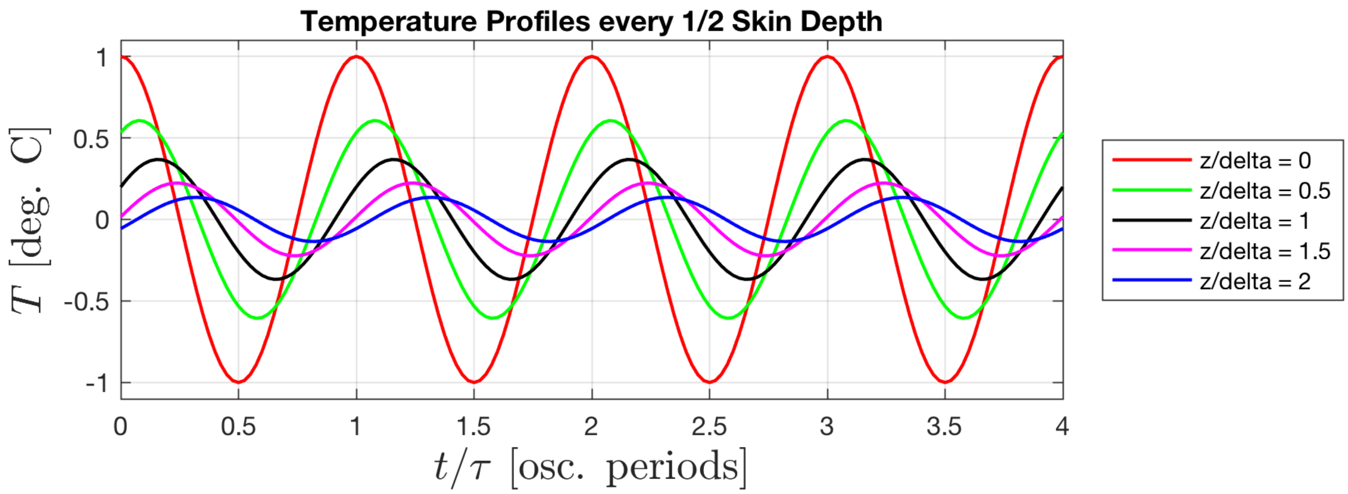


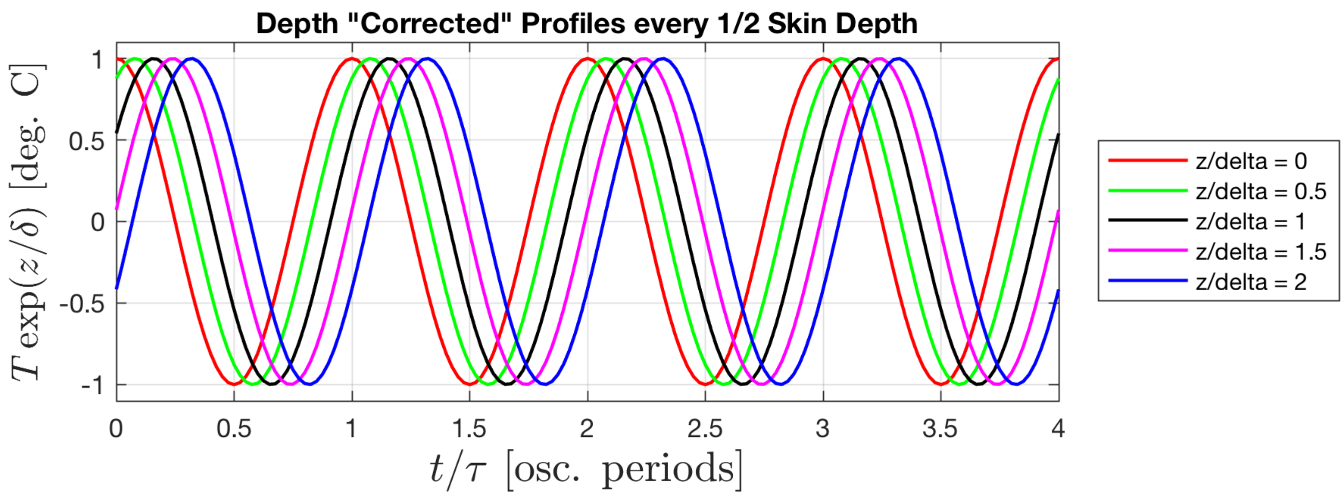
c)



Prob #3; J. Aurnou 26-Jan-2019







Prob #4

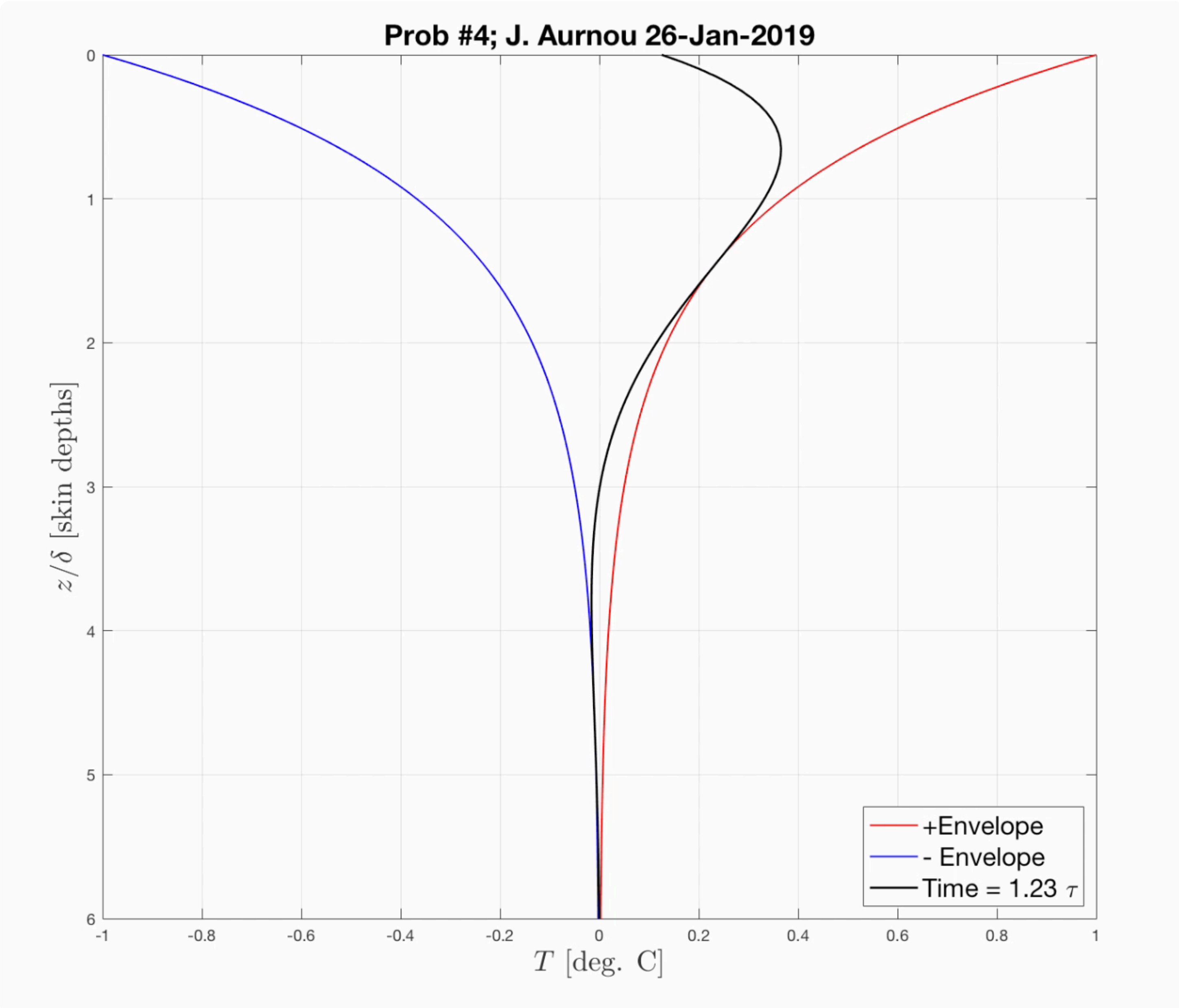
template script in HW3 CCLE directory

Output $\begin{pmatrix}\text{avi}\\ \text{or}\\ \text{mp4}\end{pmatrix}$ Movie of Prob #2 solution

$$t = 0 : (\tau/100) : 4 \cdot \tau$$

$$z = 0 : \delta/20 : 6 \cdot \delta$$

- My mp4 is in the HW3 folder on CCLE
- Snapshot from movie:



Prob #4; J. Aurnou 26-Jan-2019
z/δ [skin depths]
0
1
2
3
4
5
6
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
T [deg. C]
+Envelope
- Envelope
Time = 1.23 τ

Prob # 5

$$T(0,t) = \overbrace{A_s \cos\left(\frac{2\pi t}{16\tau}\right)}^{\text{slow wave } (s)} + \overbrace{A_f \cos\left(\frac{2\pi t}{\tau}\right)}^{\text{fast wave } (f)}$$

$\tau = 10$ min | $A_s = 1$

$\kappa \simeq 10^{-6} \frac{m^2}{s}$ | $A_f = 1/4$

$\longrightarrow \delta_{slow} = 4\delta_{fast}$

- $T(z,t) = ?$

↳ Temperature is a scalar; Skin Depth solutions can be added:

$$T(z,t) = T_f(z,t) + T_s(z,t)$$

↳ $t = 0 : \tau_{slow}$

$z = 0 : 4 \cdot \delta_{slow}$

- <u>Movie</u>:
  - ↳ Envelope of two-wave system
  - ↳ slow Wave solution
  - ↳ Full 2-wave solution
    - ↳ fast + slow
  - ↳ y-axis: z/δ_{slow}
  - ↳ Dashed horizontal $3-\delta_{fast}$ line
    - ↳ where fast wave has exp(-3) decay

↳ Report time in minutes, τ_f + τ_s units

e.g.,

- My mpeg is in the HW3 CCLE folder
- Snapshot shown below: