University of Colorado Denver
Department of Civil Engineering
CVEN-5335 Vadose Zone Hydrology

ASSIGNMENTS and ANSWERS
dcm 10/24/2018

week	notes	assignment
1		2.21, 2.23, 2.33, 4.15, 4.20
2		4.2, 4.4, 4.16, 6.6, 7.1, 7.2, 7.6, 7.9, 7.13
3		(see handout)
4		9.2, 9.5, 9.6, 9.8, 9.14
5		(see handout)
6	midterm #1	(see handout)
7		(see handout)
8		(see handout)
9		12.1, 12.2, 12.3 (optional Jensen-Haise)
10		10.3, ~~10.6,~~ 10.7 (optional Richards), 10.12
11	midterm #2	(see handout)
12		(see handout)
13		(see handout)
14		(see handout)

Answers (not in "Back of Book")
These partial answers will help determine whether you are on track. Some have been rounded.

Week 1
2.21 (a) 380 kg, (c) 1600 kg, (e) 1900 kg
2.23 3.55 g/cm^3
2.33 short essay
4.15a *hint*, assume given pressure values are suction. When P = -0.10 bar, θ = 34%.
4.15b *hint*, "plant available water" is "field capacity" minus "permanent wilting point," where all three are measured in units of moisture content θ. Field capacity is the moisture content after gravity has removed all the water it can. Permanent wilting point is the moisture content below which crops fail; below this moisture content crops cannot be revived by adding water. Assume the permanent wilting point is half the field capacity (https://www.decagon.com/en/support/how-do-i-determine-field-capacity/ 9/7/2016).
4.20 *hint*, assume "equilibrium" means total head constant throughout column

Week 2
4.16 *hint*, the CGS system uses cm, g, and s (in contrast to the MKS system's m, kg, and s)
7.1 *correction*, problem statement should be for mobility $k/\eta = 4.15 \times 10^{-7}$ m^2 Pa^{-1} s^{-1}.
7.13 *hint*, think about continuity

Week 3

1 *hint*, recall definition of derivative: $dy/dx = \lim_{\Delta x \to 0} (y|_{x+\Delta x} - y|_x)/\Delta x$

2 answers will vary

3 answers will vary

4 Brooks and Corey's (1966) parameter $n = 1.9$ optimized by least squares

5 van Genuchten's (1980) parameter $m = 1.1$ optimized by least squares

6 based on the root mean squared error (RMSE), both methods are equivalent here

Week 4

9.14 *hint*, assume $\theta_{surface} = \theta_{air}$. (a) $E_{cum} = 2.2$ cm. (b) required solar flux 53-55 MJ/(m^{2}d).

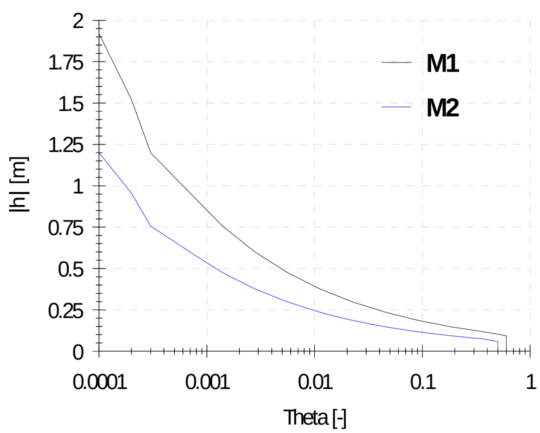
Week 5

1-2 answers given in problem statement

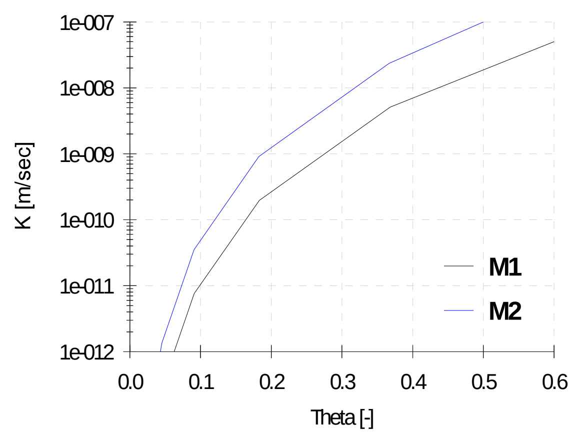
Week 6

1 After running HYDRUS-1D, you should get the following for $h(\theta)$ and $K(\theta)$:

Hydraulic Properties: Head vs. Theta



Hydraulic Properties: K vs. Theta

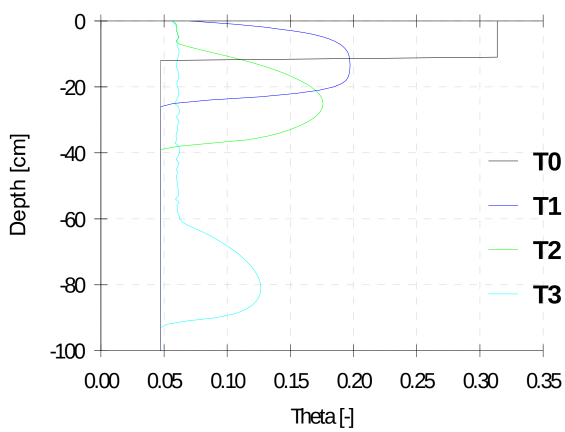


Your plots of *h(z), θ(z), and K(z)* should resemble Figures 13.3, 13.4, and 13.5.

2 (optional Fall 2018)

$\theta(z)$ should match the following, where T0 = 0 hr, T1 = 8 hr, T2 = 48 hr, and T3 = 240 hr:

Profile Information: Water Content



<u>Week 7</u>

11.4 *hint*, using corrected equations in errata list, your plot should resemble Figure 11.8

<u>Week 8</u>

1 essay answers will vary

3 S = 120 m

4 (a) S = 190 m for ditches, and 170 m for perforated pipes

(b) *hint*, allowable infiltration R_{max} depends on your selected h_o.

<u>Week 9</u>

12.1 *hints*

- download evaporation data from http://www.ucdenver.edu/dmays/5335
- for multiple regression, use Microsoft Excel's LINEST function
  - because LINEST cannot handle missing values, you will need to filter the data
  - equations (12.32)-(12.35) are erroneous

12.2 at z = 3,000 m, $P \approx$ 144 mm, and $T \approx$ 6.9 ºC

12.3 *hints*

- assume Table 12.7 is for northern latitudes (shift by 6 months for southern latitudes)
- for pan evaporation, assume a 100 m fetch of upstream alfalfa

<u>Week 10</u>

10.3 *note*, average linear velocity should be v not q, so $v = q/\theta = (Q/A)/\theta$ = 0.317 cm/hr.

note, equation (10.24) should be $D = vL/(4\pi S^2)$ = 0.13 cm^2/hr not 0.63 cm^2/hr.

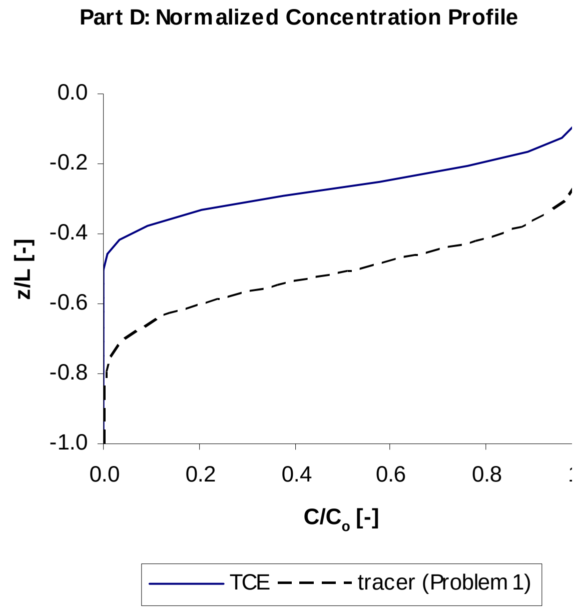
~~10.6 *note*, equation (10.51) has solubility S [mg/L] and organic carbon partitioning coefficient K_{oc} [mL/g] = [L/kg]. Accordingly, the partitioning coefficient K is also [mL/g] = [L/kg]. Finally, re-defining S, we have sorbed concentration S [µg/g] = [mg/kg].~~

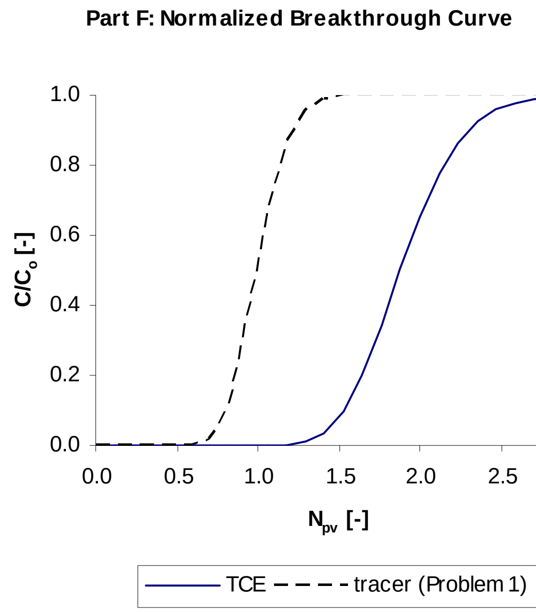
10.12 1.9 years

Week 11

1 *hint*, in Excel, calculate $A = \dfrac{Rx - vt}{2\sqrt{DRt}}$, then erf(A), then erfc(A). Repeat for $B = \dfrac{Rx + vt}{2\sqrt{DRt}}$.

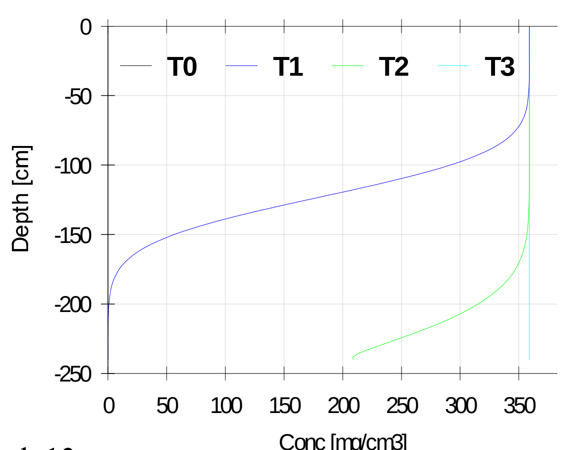
2 (Fall 2018, disregard “TCE” results below)

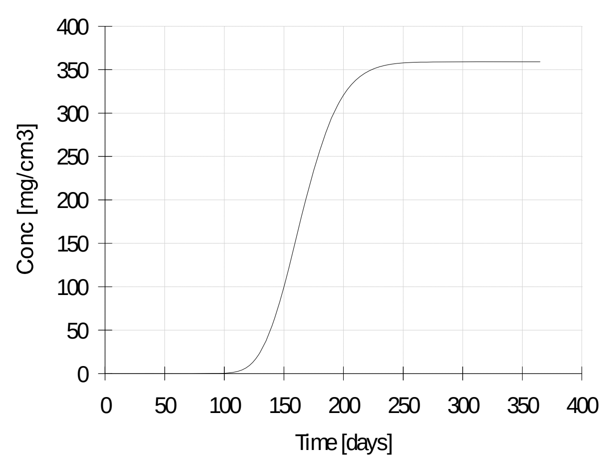




Week 12

1 Results given below, where T0 = 0 d, T1 = $t_L/2$ = 85 d, T2 = t_L = 170 d, and T3 = 365 d.





Week 13

1 answers will vary

2 (a) answers will vary

(b) *hint*, visit http://www.ucdenver.edu/dmays/3414

3 answers will vary

Week 14

1 *hint*, sand is 60% by mass and 1% by surface area

2 *hint*, assuming $d = 1$ μm and $\rho = 2.5$ g/cm^3, $s = 801.6$ m^2/g for primary particles

3 *hint*, for chemical condition F, illite is dispersed, and the other clays are flocculated

4 *hint*, sketch how electrostatic repulsive potential Ψ_R changes with ionic strength

5 answers will vary