Utah State University
Department of Civil and Environmental Engineering
CEE 6400 Physical Hydrology

Midterm exam. Date: 10/24/2012
D.G. Tarboton Time: 60 min
[75 points open book portion. 100 points total.]

Open Book Portion. Answer all questions. Please answer on separate sheets of paper. You may refer to the textbook, notes, solutions to homeworks and any other written or printed reference material that you have brought with you.
Calculator use. You may use a programmable calculator or equivalent calculating device (e.g. calculator functionality on a phone). You should limit the use of the calculating device to the performance of calculations. You may use programs that you have written to evaluate quantities commonly used in this class (e.g. saturation vapor pressure). You may not use your calculating device to retrieve stored reference material in any form. You may not send messages or access the internet or communicate in any way with anyone other than the instructor or moderator regarding solutions to these questions.

1. **Infiltration and Runoff Generation.** Consider the following storm

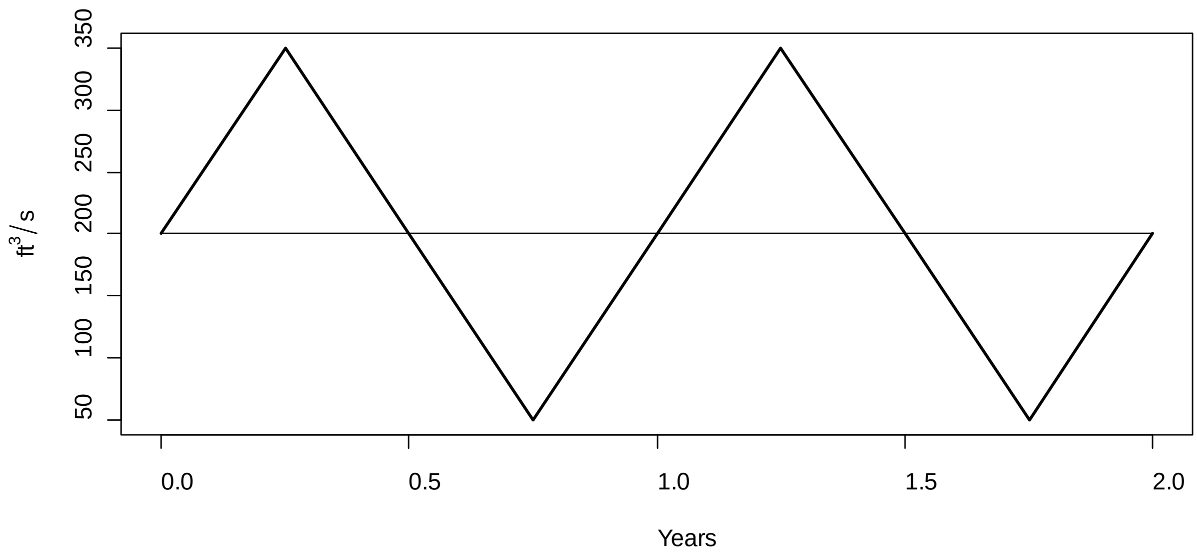
Time (h)	0-1	1-2
Rainfall Intensity (cm/h)	1	3

Philip's equation is applicable with K_p = 0.3 cm/h and S_p = 3 cm/h$^{0.5}$

a. Plot a graph of infiltration capacity as a function of infiltrated depth for this soil [8]
b. What it the time that ponding first occurs in this storm [8]
c. Determine the infiltration and runoff generated in each hour increment [8]

[24 points]

2. **Storage-Yield.** Consider a stream in which the seasonal cycle of monthly streamflow follows a perfect triangular seasonal cycle as illustrated with mean flow of 200 ft^3/s, minimum of 50 ft^3/s and maximum of 350 ft^3/s.



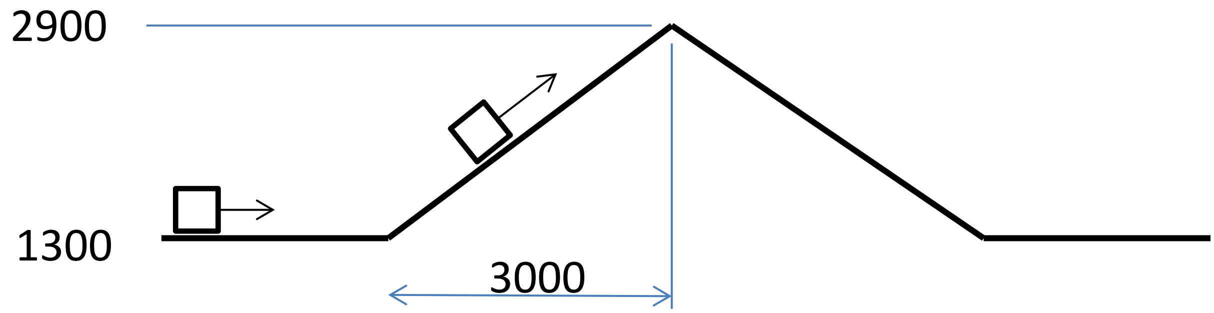
a. Determine the storage (ft^3) required to support a firm yield of 100 ft^3/s [8]
b. Determine the storage (ft^3) required to support a firm yield of 180 ft^3/s [8]
c. Plot a storage-yield diagram for this stream [8]

[24 points]

3. Consider a parcel of air being carried in a wind stream approaching a mountain front with the following conditions

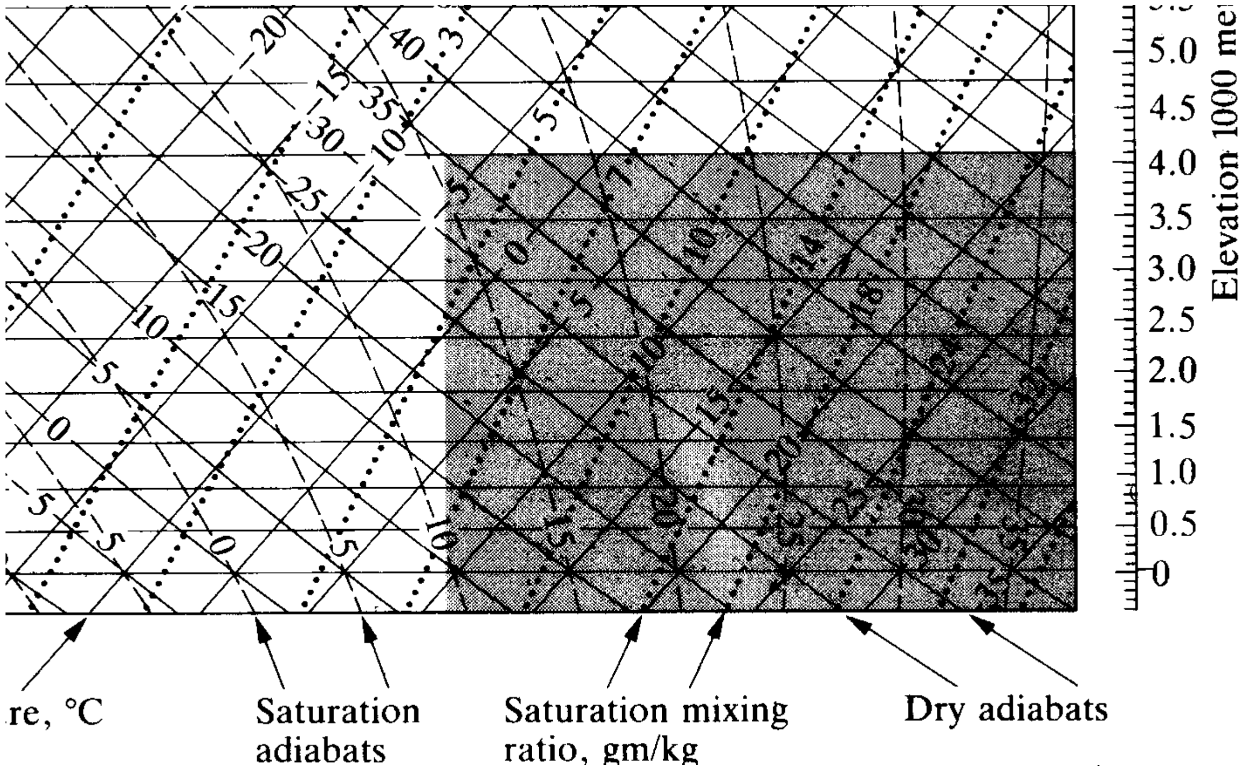
Base level atmospheric pressure = 850 hPa (elevation 1300 m)
Temperature = 5 ºC
Relative humidity = 80%
Ambient lapse rate = 8 ºC/km

The parcel is forced to rise over the mountain front. Assume adiabatic processes as the parcel is lifted and use the Pseudo-Adiabatic diagram as appropriate.



a) Determine the mixing ratio of the air parcel. [3]
b) Determine the condensation level. [3]
c) Determine the freezing level (0 °C). [3]
d) If you assume that snow falls when the temperature is below freezing indicate the portion of the mountain front that receives rain and the portion that receives snow. [3]
e) Determine the mixing ratio of the air at the top of the mountain. [3]
f) Determine the fraction of the water vapor in the air that has condensed upon it reaching the top of the mountain. [3]
g) Determine whether the parcel of air from the surface upon reaching the mountain top is conditionally unstable and comment on the potential for convective precipitation in these conditions. [3]
h) Assume that the parcel of air is returned to the base level down the back side of the mountain following an adiabatic warming process. Determine the air temperature when the parcel has returned to the base level (1300 m) [3]
i) Determine the relative humidity of the parcel of air upon returning to the base level at the back side of the mountain [3]

[27 points]


Elevation 1000 me
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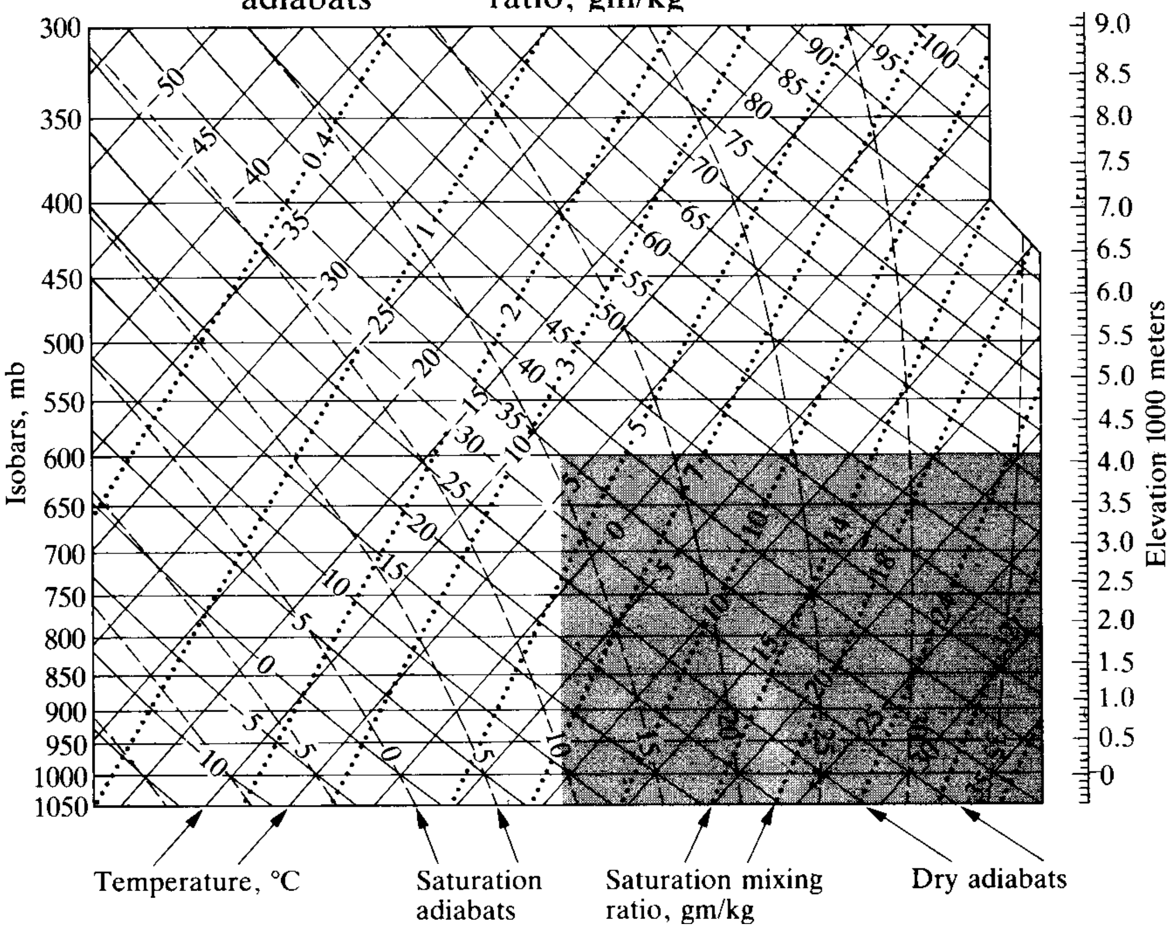
Saturation adiabats
Saturation mixing ratio, gm/kg
Dry adiabats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Elevation 1000 meters
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Saturation adiabats
Saturation mixing ratio, gm/kg
Dry adiabats