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

Final exam. Date: 12/9/2009
D.G. Tarboton Time: 90 min
60 Points

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. A watershed has the following 1 hour unit hydrograph

Time (hr)	1	2	3	4	5	6	7	8	9	10
Unit flow (m^3/s /cm)	3	7	15	12	9	7	5	3	2	1

Consider a storm in which 5 cm of precipitation falls in the first hour and 3 cm of precipitation falls in the second hour. Assume that there is 1 cm of infiltration loss in each hour.

a) Calculate the peak flow rate in the direct runoff hydrograph from this storm.
b) If someone tells you that the area of this watershed is about 25 km^2, is this plausible. Explain why or why not. [20 points]

2. The relationship between infiltration capacity and cumulative infiltration at a site has been determined from measurements to be given by

Cumulative infiltration (cm)	0	1	2	3	4	5	6	7	8	9	10
Infiltration capacity (cm/hr)	20	10	6	3	2	1	1	1	1	1	1

Consider a storm in which 12 cm of precipitation falls during 2 hours.

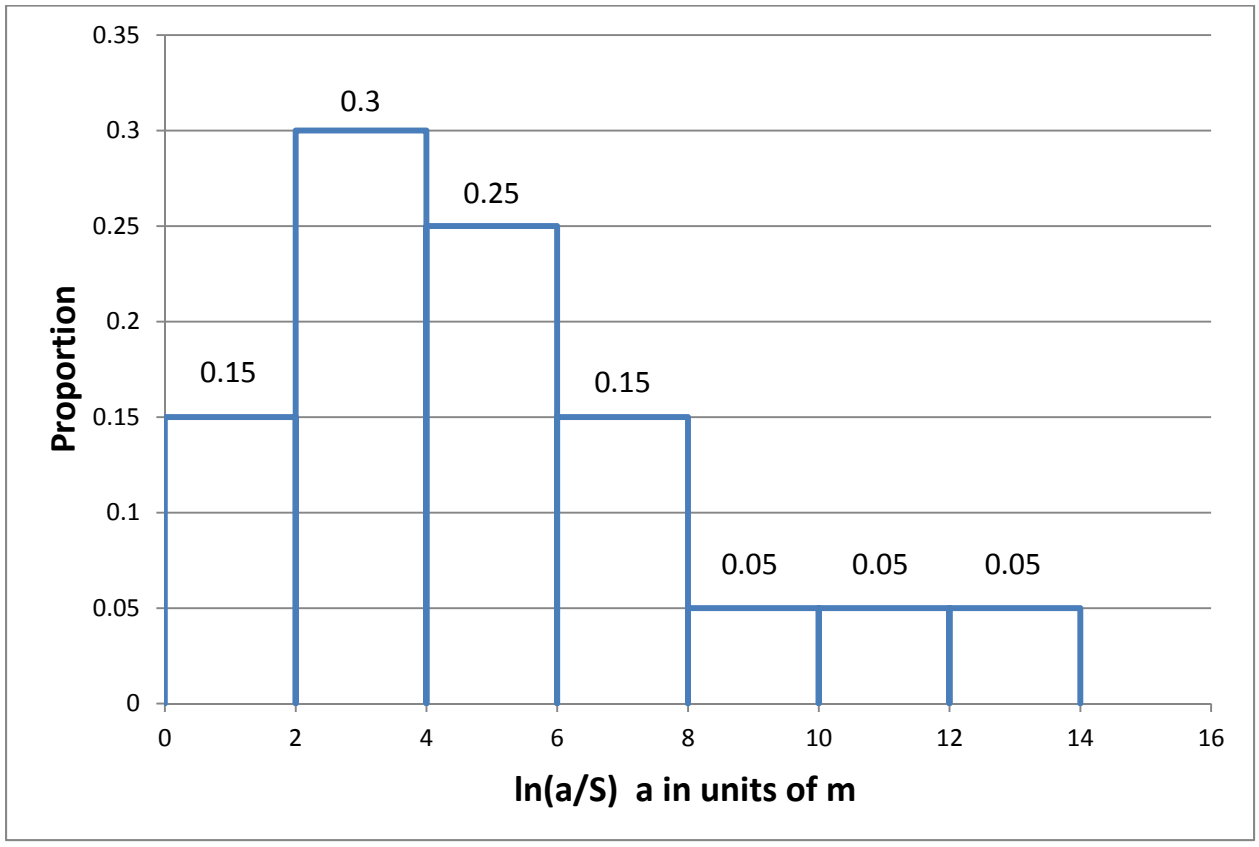
a) Calculate the time to ponding.
b) Calculate the depth of direct runoff from this storm. [20 points]

3. Consider that you are involved in a research study to evaluate how well TOPMODEL works for a specific watershed. The watershed area is 50 km^2. A number of soil pits were dug around this watershed and soil samples from different depths taken to measure the hydraulic conductivity. The following table gives depth and average saturated hydraulic conductivity from this information.

Depth (m)	0	0.1	0.5	1
Hydraulic conductivity (m/hr)	3	2.6	1.4	0.67

From the soil samples the effective porosity was determined to be 0.25.

Based on analysis of a digital elevation model the following histogram has been calculated that gives the distribution of the ln(a/S) wetness index.



a) Calculate the TOPMODEL parameters λ (or $\bar{\lambda}$) and f for this watershed.
b) Given a baseflow of 1.4 m^3/s from this watershed estimate the saturated area at the start of a storm.
c) Consider a storm with 80 mm of total rainfall. Calculate the volume of direct runoff from this storm. [20 points]