Utah State University
Department of Civil and Environmental Engineering
CEE 3430 Engineering Hydrology

Final Exam — Date: 4/30/2012
D.G. Tarboton — Time: 110 min
80 Points

Open Book. Answer all questions. **Please answer on separate sheets of paper**. You may refer to the textbook, notes, solutions to homework 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).

Computer use. You may use a laptop computer to access an electronic version of the textbook. You may not send emails or messages or communicate in any way with anyone other than the instructor or moderator regarding solutions to these questions.

1. Consider an unconfined aquifer overlying impermeable bedrock with the following properties
   Porosity 27%
   Specific retention 12%
   Thickness 15 m
   Hydraulic conductivity 12 m/day
   a) Assume that there is 2 cm of precipitation that all infiltrates and percolates to the water table, calculate the water level rise (m). [10]
   b) How much water can be produced by lowering the water table by 2 m over an area of 1 km^2. Report you your result in m^3. [10]

   [20 points]

2. For a particular location the average net radiation is 145 W/m^2, air temperature is 24 °C, relative humidity is 65%, the wind speed is 1.5 m/s at a height of 2 m, and the roughness height z_o is 0.02 cm.
   a) Determine the open water evaporation rate using the combined method (mm/d). [10]
   b) Determine the fraction of net radiation that is used in evaporation. [5]
   c) Explain what happens to the energy from net radiation that is not used in evaporation. [5]

   [20 points]

3. A watershed draining into a flood detention reservoir has the following 30 min unit hydrograph

Time (min)	0	30	60	90	120	150
30 min UH ($m^3/s/cm$)	0	4.5	11.5	8	2.5	0

Infiltration may be calculated using the ϕ index method with ϕ=1.5 cm/h. The flood detention basin has a volume of 60,000 m^3 and the design is such that there is no outflow until this volume is reached, and any inflow volume in excess of this amount spills and becomes outflow. The detention basin is initially empty and there is no baseflow from this watershed.

Consider the following storm

Time	0-30 min	30-60 min	60-90 min
Rainfall	0.5 cm	2 cm	1 cm

Determine the following

a) Excess precipitation in each time interval. [6]
b) The volume of the inflow into the detention basin. [6]
c) Determine whether the detention basin fills. [4]
d) If the detention basin fills determine the volume of the outflow. If the detention basin does not fill, determine the remaining unfilled volume. [4]

[20 points]

4. The storage capacity and stage-outflow relationship of a flood control reservoir are given by the following table.

Stage (m)	5.0	5.5	6
Storage (m^3)	0	7200	14400
Discharge (m^3/s)	0	1	7

You may use linear interpolation to determine storage and discharge quantities between these values.

Following is inflow to this reservoir from a storm

Time (hr)	0	1	2	3
Inflow (m^3/s)	0	3	5.2	0

Inflows should be assumed to vary linearly between these times.

The initial reservoir stage is 5.0 m.

a) Calculate the volume (in m^3) of the inflow hydrograph. [6]
b) Route the inflow hydrograph through the reservoir using 1 hour time steps. Continue your calculations for a sufficient number of time steps to identify the peak discharge rate and report this peak discharge rate. [14]

[20 points]