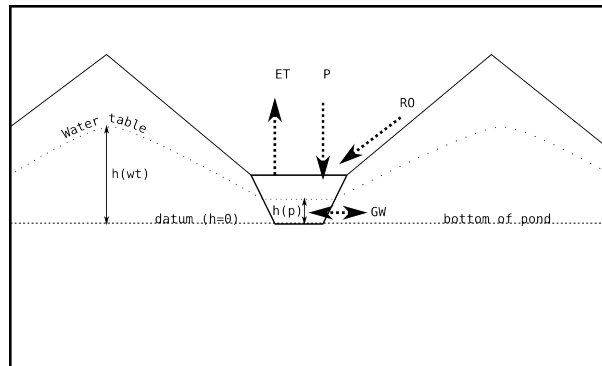Name: _____
Problem Set:ODE's
ERS 420

Purpose

Calculate the amount of water in a small pond over time, based on precipitation and temperature, by numerically solving a set of ordinary differential equation.

Problem

Small pools occur in landscapes across New England, and these ponds can be important habitat. If a pond has no channelized surface-water inflow or outflow, all water exchange is due to evapotranspiration (ET), precipitation(P) and associated overland runoff (RO), and exchange with groundwater. In this contrived basin,

- Temperature(T) also varies in a sinusoidal fashion from 1 to 24 degrees C, with a peak in the midpoint of the year.

- P varies over a year from 0.2 mm/day to 1.8 mm/day in a sinusoidal fashion, with a peak rate in the late spring (Julian day 120). Assume 15% of all precipitation hitting the basin flows into the pond.

- ET (mm^3/day) at the pond is: $ET = \frac{dV}{dt} = A \cdot 29.8 \cdot 12 \frac{e(t)}{T+273.2}$ where the saturated vapor pressure(e) is $e(t) = 0.611 \cdot exp\left(\frac{17.3T}{T+237.3}\right)$. Note that a is the surface area in sq. mm.

- Assume ground-water level is constant (-2000 mm) and the exchange between ground water and the pond is: $GW = \frac{dV}{dt} = K \cdot A(h_{GW} - h_P)$. The exchange coefficient (K) is based based on hydraulic conductivity and should be set at $2 \cdot 10^{-3}$ mm/day/mm. Assume ground water flows uniformly across the 'walls' of the pond.

- The drainage basin surrounding the pond has an area of 20 acres.

- the pond has a surface area of 0.5 acres and an initial water level of 0 (2000 mm above groundwater level).

1. Use these conditions and assumptions to simulate the water level in the pond over time using the midpoint method (2nd order Runge Kutta).

2. Modify the 'ET function' to better simulate ET when the water level in the pond falls below the ground surface.

Expectation

Turn in a typed report, including script and graphics as appropriate, that includes the following sections:

Methods Concisely describe the equations used to simulate the water levels in the pond.

Results and Discussion

- Describe the 'natural' hydroperiod (water levels and timing) in this pond.
- Describe what will happen if the area warms 4 degrees C.
- Describe what will happen if a large bottled water company extracts ground water and locally lowers ground-water levels by 4 meters.
- How sensitive is pond water level to hydraulic conductivity?

Graduate students should do this by creating a 'pond' class that includes ET, precipitation, and groundwater functions.

To impress the professor Change precipitation from a continuous function to randomly generated daily events with similar seasonal precipitation amounts.