SULTAN QABOOS UNIVERSITY

Mid-Term Examination, Spring Semester 2006

ENGINEERING HYDROLOGY   **CIVL 3066**

April 9, 2006

Candidates are permitted to bring into the examination room:

Calculator (programmable or non-programmable).

Instructions to candidates:

1. Answer all the questions
2. The paper consists of FOUR questions.
3. Maximum allowed time is 90 minutes.
4. Assume water density as 1000 kg/m^3 wherever required.
5. Assume kinematic viscosity of the water as 0.01cm^2/s wherever required.

NAME: **ID #:**

Date:

Question	1	2	3	4	Total
Marks					

1.

For a sandy loam soil, calculate the infiltration rate (cm/hr) and depth of infiltration (cm) after one hour if the effective saturation is initially 40 percent, using the Green-Ampt method. Assume continuously ponded condition. **[25%]**

2.

The precipitation and streamflow for a storm are shown in the table below for a watershed having an area of 18 km^2.

    (a) Calculate the time distribution of storage on the watershed assuming that the initial storage is zero. **[15]**

    (b) Compute the total depth of precipitation and the equivalent depth of streamflow occurred during the 4-hour period. **[5]**

    (c) How much storage remained in the watershed at the end of the period? **[5]**

No.	Time (hr)	Incremental Precipitation (cm)	Instantaneous Streamflow (m^3/sec)			
1	0		0.71			
2	0.5	0.46	1.08			
3	1.0	1.07	8.78			
4	1.5	0.53	18.55			
5	2.0		30.01			
6	2.5		27.40			
7	3.0		23.46			
8	3.5		15.03			
9	4.0		7.68			

3

3.

A rectangular open channel 10m wide and 1m deep has a slope of 0.001 and is lined with cemented rubble ($n=0.025$). Determine

(a) its maximum discharge capacity, and **[10]**

(b) the maximum discharge obtainable by changing the cross-sectional dimensions without changing the rectangular form of the section, the slope and the volume of excavation. **[15]**

4.

Develop new functions to be used in MS-Excel for solving the following equations that require trials or successive substitution. List complete VBA programs that will return the output value using the input values given with each equation:

(a) $\dfrac{1}{\sqrt{f}} = -2\log_{10}\left[\dfrac{k_s}{12R} + \dfrac{2.5}{R_N\sqrt{f}}\right]$

Required output: f= friction factor

Input values: R= Hydraulic radius, R_N= Reynolds number and k_s=roughness height.

[10]

4.

(b) $F = Kt + \psi\Delta\theta \ln\left(1 + \dfrac{F}{\psi\Delta\theta}\right)$

Required output: F= cumulative infiltration

Input values: K= hydraulic conductivity, ψ =suction head and $\Delta\theta$ = change in moisture content of the soil due to infiltration. **[15]**

The following information may be useful in solving the problems.

$$\tau = \rho v \frac{du}{dz} \qquad \tau_{turb} = \rho K_m \frac{du}{dz} \qquad \frac{u}{u^*} = \frac{1}{\kappa}\ln\left(\frac{z}{z_0}\right)$$

$$f(t) = f_c + (f_0 - f_c)e^{-kt}, \qquad F(t) = S\sqrt{t} + Kt$$

$$f(t) = \frac{1}{2}\frac{S}{\sqrt{t}} + K, \qquad F(t) - \psi\Delta\theta\ln\left(1 + \frac{F(t)}{\psi\Delta\theta}\right) = Kt$$

$$f = K\left(\frac{\psi\Delta\theta + F)}{F}\right) = \frac{dF}{dt}, \qquad \Delta\theta = (1 - s_e)\theta_e$$

$$e_s = 611\exp(\frac{17.3T}{T + 237.3}), \qquad E_t = \frac{\Delta SM}{\Delta t} = \frac{\sum_{i=1}^{n}(\theta_1 - \theta_2)\Delta S_i + I - D}{\Delta t}$$

$$Q = \frac{1}{n}AR^{2/3}S_f^{1/2}$$

TABLE 4.3.1
Green-Ampt infiltration parameters for various soil classes

Soil class	Porosity	Effective porosity	Wetting front soil suction head	Hydraulic conductivity
	η	θ_e	ψ (cm)	K (cm/h)
Sand	0.437	0.417	4.95	11.78
	(0.374–0.500)	(0.354–0.480)	(0.97–25.36)	
Loamy sand	0.437	0.401	6.13	2.99
	(0.363–0.506)	(0.329–0.473)	(1.35–27.94)	
Sandy loam	0.453	0.412	11.01	1.09
	(0.351–0.555)	(0.283–0.541)	(2.67–45.47)	
Loam	0.463	0.434	8.89	0.34
	(0.375–0.551)	(0.334–0.534)	(1.33–59.38)	
Silt loam	0.501	0.486	16.68	0.65
	(0.420–0.582)	(0.394–0.578)	(2.92–95.39)	
Sandy clay loam	0.398	0.330	21.85	0.15
	(0.332–0.464)	(0.235–0.425)	(4.42–108.0)	
Clay loam	0.464	0.309	20.88	0.10
	(0.409–0.519)	(0.279–0.501)	(4.79–91.10)	
Silty clay loam	0.471	0.432	27.30	0.10
	(0.418–0.524)	(0.347–0.517)	(5.67–131.50)	
Sandy clay	0.430	0.321	23.90	0.06
	(0.370–0.490)	(0.207–0.435)	(4.08–140.2)	
Silty clay	0.479	0.423	29.22	0.05
	(0.425–0.533)	(0.334–0.512)	(6.13–139.4)	
Clay	0.475	0.385	31.63	0.03
	(0.427–0.523)	(0.269–0.501)	(6.39–156.5)	

The numbers in parentheses below each parameter are one standard deviation around the parameter value given. *Source:* Rawls, Brakensiek, and Miller, 1983.