UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION PAPER

2012

PROGRAMME: B.SC.

COURSE CODE: LUM 403

TITLE OF PAPER: IRRIGATION WATER MANAGEMENT

ALLOWED TIME: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: Calculator

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS

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SECTION ONE: COMPULSORY QUESTION

QUESTION ONE

a) Discuss five advantages and five disadvantages of trickle irrigation system. {10marks}

b) Water flows in a pipe at a velocity of 1.5m/s. If the discharge is measured to be 11.8 l/s, what is the diameter of the pipe? {4 marks}

c) Consider a steady flow of water through a nozzle in which the upstream diameter D1 = 30 cm reduces to a downstream diameter of D2 = 20cm. For a flow rate of 8 L/s, compute the mean velocities for the upstream and downstream diameters. {6 marks}

d) A soil has an available moisture content of 80mm/m. A sprinkler system is to be designed to irrigate cotton. Based on climatic data, the peak period crop water requirement is 11mm/d. The soil is a light sand with a total depth of 1.7m. The management allowed depletion is 60%. The maximum crop rooting depth is 3m.

   i) compute the irrigation interval. {6 marks}

   ii) If the irrigated area is 10ha, and the sprinkler stand time is 12hrs, compute the system capacity. {4 marks}

e) A sprinkler system has a gross depth of irrigation required equal to 131mm. The operating pressure at the sprinkler nozzle is 380KPa. The area to be irrigated is 2ha with a time of operation of 20hrs. The overall pump efficiency is 70 percent. At full operation, the pump is taking water from a water table 23m below the height of the sprinkler nozzle. What size pump is required to meet the demand if the head losses up to the sprinkler nozzle are equivalent to 7.6m of head? {10marks}

SECTION II: ANSWER ANY TWO QUESTION

QUESTION TWO

Famer Harris is a member of a large irrigation district which has as its water source a storage reservoir 60km upstream from the entrance to the distribution system. He wants to irrigate a 65 hectare parcel of maize by center pivot. The crop water requirements since the last irrigation is estimated as 50mm. Due to the expected uniformity of the center pivot system, an areal average of 55mm of water will have to be applied to the field to ensure that all parts of the field receive a minimum of 50mm. Estimated spray and wind drift losses are 8 percent of the water discharge through the sprinkler nozzles. Distribution losses from where the water enters the irrigation district in a canal to the head of Farmer Harris's field is estimated at 15 percent. Seepage and evaporation losses in the unlined canal between the storage reservoir and the entrance to the district distribution system are 45 percent. Compute the applicable irrigation efficiencies and volume of water (m3) which must be released from the storage reservoir to meet Farmer Harris's crop water requirements? {30marks}

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QUESTION THREE

a) A trial configuration of a hand move sprinkler system has a lateral running downslope from a mainline along a constant grade of 0.005 m/m. The design operating pressure of the nozzle is 310 kPa. The lateral has a length of 400m between the first and last sprinkler.

i) Compute the maximum allowable headloss due to friction. {10marks}

ii) Determine the required pipe diameter to maintain actual headloss within the allowable limit. The sprinkler spacing is 12m. The design discharge per nozzle is 0.315 l/s. {10marks}

b) A centrifugal pump is to be installed at a site with an elevation of 400m (P_{atm} = 9.9m) where it will be required to pump water at 30°C (P_v = 0.43m). The water source is exposed to the atmosphere and the friction losses on the suction side of the pump are estimated at 0.6m. The net positive suction head required from the manufacturer's specification is 5.2m.

i) Compute the maximum height that the centreline of the pump intake may be placed above the level of the water source. {5marks}

ii) if a safety factor of 0.6 m is required, determine the maximum allowable height of the pipe center line. {5marks}

QUESTION FOUR

a) Determine the required diameter for an orifice emitter in a turbulent flow regime with a design discharge of 10 L/h and operating pressure head of 10 m. Assume a value of 0.6 for the orifice coefficient. {5 marks}

b) Compute the required length of a long-path emitter for a system with a design discharge of 28 L/h and operating pressure head of 10 m. Assume the standard value of 1.0×10^{-6} m^2/s for the kinematic viscosity of water. Use a value of 0.003 mm for the absolute roughness {15marks}

c) A drip emitter discharges 3.0 L/h at a head of 5.0 m. The same emitter discharges 4.0 L/h when the head is 10 m. Find the discharge exponent, x; the discharge coefficient, K_d, and the head at which q = 5.0 L/h. {10marks}

FURROW EQUATIONS

$T_{co} + T_d = T_r - T_L$, $E_a = \frac{Z_{req} L}{Q_0 T_{co}}$, $P = 0.265 \left[\frac{Q*n}{S^{0.5}}\right]^{0.425} + 0.227$; $i = [at^b + c]\frac{P}{W}$

$T_t = \frac{x}{f} exp\left[\frac{g*x}{Q*S^{0.5}}\right]$; $T_n = \left[\frac{i_n\left(\frac{W}{P}\right) - c}{a}\right]^{1/b}$; $T_o = T_{co} - T_t$

$T_{co} = T_t + T_n$; $\beta = \frac{g*x}{Q*S^{0.5}}$; $i_g = \frac{i_n}{\frac{e_d}{100}}$; $i_g = \frac{60*Q*T_{co}}{WL}$

$T_{0-x} = T_{co} - \frac{0.0929}{f(x)\left[\frac{0.305\beta}{x}\right]^2}[(\beta - 1)\exp(\beta) + 1]$, $d_{ro} = i_g - i_{avg}$; $d_{dp} = i_{avg} - i_n$

Table 1. Intake family and advance coefficients for depth of infiltration in mm, time in minutes, and length in meters.

Intake Family	a	b	c	f	g * 10^{-4}
0.05	0.5334	0.618	7.0	7.16	1.088
0.10	0.6198	0.661	7.0	7.25	1.251
0.15	0.7110	0.683	7.0	7.34	1.414
0.20	0.7772	0.699	7.0	7.43	1.578
0.25	0.8534	0.711	7.0	7.52	1.741
0.30	0.9246	0.720	7.0	7.61	1.904
0.35	0.9957	0.729	7.0	7.70	2.067
0.40	1.064	0.736	7.0	7.79	2.230
0.45	1.130	0.742	7.0	7.88	2.393
0.50	1.196	0.748	7.0	7.97	2.556
0.60	1.321	0.757	7.0	8.15	2.883
0.70	1.443	0.766	7.0	8.33	3.209
0.80	1.560	0.773	7.0	8.50	3.535
0.90	1.674	0.779	7.0	8.68	3.862
1.00	1.786	0.785	7.0	8.86	4.188
1.50	2.284	0.799	7.0	9.76	5.819
2.00	2.753	0.808	7.0	10.65	7.451

SOME USEFUL EQUATIONS

$$d = \frac{d_n}{(\frac{Ea}{100})}, \qquad d = \frac{0.9 * d_n}{(1.0 - LR) * Ea/100}, \qquad Q_s = K\frac{A * d}{f * T}, \qquad h_f = F_y * \frac{L}{D} * \frac{V^2}{2g}$$

$$J = \frac{h_f}{\frac{L}{100}} = K(\frac{Q}{C})^{1.852} D^{-4.87}, \qquad R_y = K * \frac{Q}{D}, \qquad P_s = \frac{\rho g Q H}{\aleph}$$

$$F = \frac{1}{b+1} + \frac{1}{2N} + \frac{(b-1)^{0.5}}{6N^2}, \; H_l = H_a + \frac{3h_f}{4} + \frac{1\Delta H_e}{2} + H_r, \; NPSHa = P_{atm} - P_v - h_{fs} - Z$$

DRIP EQUATIONS

$$R_n = \frac{V * D}{1000 * \vartheta}, \; f = \frac{h_f}{\frac{L}{D} * \frac{V^2}{2g}}, q = 3.6 * A * Co * (2gH)^{0.5}$$

$$q = 0.11384 * A * \left[2g(\frac{HD}{f * L})\right]^{0.5}, \; q = 0.11384 * A * \left[2g(\frac{\sqrt{H}D}{f * L})\right]^{0.5}$$

$$f = 64/R_n, \; \frac{1}{\sqrt{f}} = 2Log\left(\frac{D}{\epsilon}\right) + 1.14, q = k * H^x, \; U_e = 100\left[1.0 - \frac{1.27}{n} * C_v\right] * \frac{q_{min}}{q_{avg}}$$