UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION PAPER

2016

PROGRAMME: B.SC. ABE

COURSE CODE: ABE 403

TITLE OF PAPER: IRRIGATION DESIGN AND MANAGEMENT

ALLOWED TIME: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: Calculator, formula sheet, Intake Family Table.

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS

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SECTION A: COMPULSORY QUESTION

QUESTION ONE

a) A farmer in Egypt has planted vegetables under micro sprinkler irrigation system. After two years of cropping he realized that he needs to install drains. Discuss two reasons that might have contributed to this requirement. {10 marks}

b) A pipeline changes area from 0.5 m^2 to 0.25 m^2. If the velocity in the smaller pipe is 1.0 m/s. Calculate the velocity in the larger pipe. {4 marks}

c) Calculate the kinetic energy in a pipeline when the flow velocity is 3.7 m/s. {3 marks}

d) Calculate the equivalent pressure for the pipeline in b) above in kN/m^2. {4 marks}

e) A pipeline is constructed along undulating ground. Two points, point 1 and 2 are selected on the pipeline. Point 2 is lower than point 1.

i) Calculate the pressure at point 2 when the pressure at point 1 is 150 kN/m^2 and point 2 is 7.5 m below point 1. {11marks}

ii) Are you surprised by the pressure in point 2 relative to point 1. State your reasoning. {4 marks}

f) Given a field of corn, area 16ha, consumption rate 5mm/d, moisture replaced at each irrigation 60mm, irrigation efficiency 75%, irrigation period f = 10days, system operating time per day 20hr, electrical conductivity of the irrigation water 2.1 dS/m. Compute the system capacity. {4 marks}

SECTION B: ANSWER ANY TWO QUESTIONS

QUESTION TWO

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) i) Name any four factors that affect the design of a furrow system {4 marks}

ii) Name any five head parameters that are important in the design of a mainline system. {5 marks}

ii) Sugarcane sometimes show sign of wilting even when the soil is wet. What are the possible explanation for this phenomenon. {6 marks}

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}

QUESTION THREE

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

b) 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}

c) A trapezoidal concrete canal is designed to carry 70 L/s. The canals channel has a bottom width of 30 cm, side slope z = 1.25, a water depth of 22.5 cm and a freeboard of 7.5 cm. Calculate;

i) the canal's cross sectional area {4marks}
ii) the wetted perimeter {3marks}
iii) the hydraulic radius {3marks}
iv) the surface slope {3marks}
v) If the canal is 862 m long, what is the expected headloss along the canal? {2marks}

QUESTION FOUR

a) Draw a completely labeled furrow advance recession graph showing the subsurface distribution of water. {20marks}

b) Calculate the discharge, Q, of a rectangular channel if the width is 2.438 m, with a depth of flow of 0.610 m and the bed slope of 0.0004 m/m. Use a Manning's roughness coefficient of n = 0.015. {10marks}

SOME USEFUL EQUATIONS

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

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

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

DRIP EQUATIONS

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

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

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

FURROW EQUATIONS

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

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

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

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

OPEN CHANNEL FLOW EQUATIONS

$$A = b_w y; A = (b_w + zy)y; P = b_w + 2y; P = b_w + 2y\sqrt{1+z^2}; R_h = \frac{b_w y}{b_w + 2y}$$

$$R_h = \frac{(b_w+zy)y}{b_w+2y\sqrt{1+z^2}}; \; T_w = b_w; T_w = b_w + 2zy$$

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