TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT BUILDING AND CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BSC IN CIVIL ENGINEERING

ECE 2413: **IRRIGATION ENGINEERING II**

END OF SEMESTER EXAMINATION

SERIES: APRIL 2016

TIME: 2HOURS

DATE: 12May2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, Drawing Instruments, Scientific calculator, examination pass and student ID

This paper consists of five questions. Attemptquestion ONE (Compulsory) and any other TWO questions.

Question One (Compulsory-30 Marks)

(a)An irrigation pipeline with 200mm inside diameter and 340m in length made of new PVC is laid along a horizontal grade. The required flow rate in the pipe at steady state is 40l/s. Using Hazen-Williams equation, where C=150, calculate the friction loss along the pipe. (2 marks)

(b)Consider 15m x15m spacing for a 4.0mm nozzle operating at 350kPA pressure delivering 1.16m^3/hr at 5.37mm/hr precipitation rate. The farm size is 600m x300m. Assume the mainline is placed at the edge of the 600m length and the laterals on the 300m length. Irrigation of the farm is completed in 5days (Divide the farm into five blocks).

Calculate

(i)The number of sprinklers in a lateral (2 marks)

(ii)The number of laterals (2 marks)

(iii)The system discharge (4 marks)

(c)A farm is situated in Naivasha area. The crops to be grown are pastures. The area to be irrigated is 15 Ha. The farmer would like to irrigate using a drag line system. The system efficiency (n_s) =82%. Soil basic infiltration rate = 10mm/hr. Water holding capacity (WHC) =100mm/m. Class A pan peak evaporation rate (E_o) =5.8mm/day; Crop factor (f) =0.7;

Rainfall(R) =0mm; Percentage allowable depletion (α) =50%; Natural root depth = 1.0m

Effective root depth = 0.3m

Assume a spacing of 12m x 12m and an application rate of between 6 to 9mm/hr.

Calculate:

(i)Readily Available Water (2 marks)

(ii)Gross Irrigation Requirement (2 marks)

(iii)Cycle Length/Irrigation Interval (3 marks)

(iv)Net application rate (3 marks)

(v)Standing Time (3 marks)

(vi)Number of sprinkler operating (3 marks)

(vii)System capacity (4 marks)

Question Two (20 Marks)

(a)Assuming that an emitter with the following characteristics are provided by the manufacturer and are considered for use; q=4lph, H=10m, C_v=0.07, x=0.42 and q_a=4.32lph. Consider citrus grown on fairly level ground, spaced at 6m x 6m and a design EU of 90%.

Calculate the allowable pressure variation. (2 marks)

(b)The following data is given for a drip irrigation system:

Area: 150m x 300m; Topography: Flat; Crops: Citrus; Spacing: 6m x 6m

Two drip lines are provided for each line of tree; each citrus tree is provided with 6 drippers, 3 per lateral. Divide the farm into 4 submains (manifold) with the first two submains operating together (Shift 1) and the last two manifolds operating together (Shift 2).

Emitter discharge = 4.32lph; K = 1.22×10^{10}; C=150 for plastic pipes.

Use 16mm hose for the laterals, 50mm for submain and 75mm for mainline.

The Christiansen friction factor F is given by:

$$F = \frac{1}{m+1} + \frac{1}{2N} + \frac{(m-1)^{1/2}}{6N^2}$$

where N=Number of emitters along the lateral; m= exponent of velocity = 1.852 for Hazen-William equation.

Design the drip irrigation system and draw a schematic lay out. Calculate

(i)The number of emitters per lateral (2 marks)

(ii)The discharge in the lateral (2 marks)

(iii)The headloss in the lateral (3 marks)

(iv)Discharge in the submains (2 marks)

(v)Headloss in the submains (3 marks)

(vi)Discharge in the mainline (3 marks)

(vii)Headloss in the mainline (3 marks)

Question Three (20 Marks)

(a)(i)What are the advantages and disadvantages of a gravity fed irrigation system? (2 marks)

(ii)Define the following parameters:- Weirs and Barrages (2 marks)

(iii)Highlight the merits and demerits of using weirs and barrages as diversion structures. (2 marks)

(iv)What are the limitations of using gravity fed irrigation systems? (2 marks)

(b)An irrigation scheme requires a fully supply at its head of 100.15m with the following hydraulic properties of the main canal:

$Q_{design} = 0.200 m^3/s$; d=0.45m; b=0.80m; m=1; s=0.1%; $K_m = 27 m^{1/3}/s$

The automatic intake regulator consists of two orifices, one at the intake, the other one at chainage 220m of the canal together with a side weir. A gully crossing is to be constructed to

cross a natural drain. The hydraulic losses for design flow ($0.200m^3/$) are 0.08m for each orifice and 0.18m for the gully crossing. The length of the canal is 1500m. The flow with a probability of non-exceedance of 20% has been calculated as $0.600m^3/s$. The weir crest length is 9m and C=1.45.

Calculate

(i)The required river water level (4 marks)

(ii)The weir crest level (4 marks)

(c)A discharge of $1.6m^3/s$ has to be abstracted from a river into an open conveyance canal. The base flow water level of the river is 125.45m. The design water level in the canal is 124.85m and the water depth is 0.60m. The weir coefficient is 1.60. The width of the intake is 1.50m and the length of the weir is 0.50m. What is the elevation of the side weir? (4 Marks)

Question Four(20 Marks)

(a)If a pump delivers 45l/s to Ahero irrigation scheme at a head of 32m and runs at 1200rpm,
(i)What would be the discharge and head at 2000rpm? (3 marks)

(ii)What would be the break power of the pump be if it were 16.38KW at 1200rpm? (3 marks)

(b)A 14 Ha drag hose sprinkler irrigation scheme in Naivasha, designed to satisfy 20hrs/day pumping at peak demand requires a discharge of $57m^3/s$. Its TDH is 56m (20m static lift, 30m sprinkler operating head and 6m friction losses). The net irrigation requirements are $131250m^3$/year. Assume 75% irrigation efficiency, pump efficiency of 69%, overall derating of 20%. Assume a motor efficiency of 88%.

Calculate the energy requirements. (6 marks)

(c)A discharge of 78.30 l/sec has to be delivered through a 7 km long canal with a wetted cross-section of 0.19 m^2. When should the headwork gate be opened, if water has to reach the field at 07.00 hours? (4 marks)

(d)Calculate the NPSHA for a pump to operate at an elevation of 2000m under 35 degrees Celsius temperature. The friction losses in the suction pipe were calculated to be 0.7m and the suction lift to be 2m (Vapour pressure of water at 35 degrees Celsius is 0.58m). (4 marks)

Question Five (20 Marks)

(a)A stream size of 150l/s was released from the diversion headwork to irrigate a land of area 1.8 Ha. The stream size when measured at the delivery to the field channels is 120l/s. The stream continued for h hours. The effective root zone depth is 1.80m. The application losses in the field are estimated to be 440m^3. The depth of water penetration was 1.80m and 1.20m at the head and tail of the run respectively. The available water holding capacity of the soil is 21cm/m and irrigation was done at 60% depletion of AMC. The stream size delivered to the plot was 100 l/s.

Calculate:

(i)Conveyance efficiency (2 marks)

(ii)Field canal efficiency (2 marks)

(iii)Water application efficiency (2 marks)

(iv)Water storage efficiency (2 marks)

(v)Distribution efficiency (2 marks)

(b)In an agricultural area high water table occur. A subsurface drainage system is to be installed to control the water table under the following conditions: Design discharge rate is 1mm/day; The depth of the water table midway between the drains is to be kept a 1.0 m below the ground surface. Drains will be installed at a depth of 2m; PVC drainpipes with a radius of 0.10 m will be used. A deep auguring revealed that there is a layer of low conductivity at 6.8 m, which can be

regarded as the base of the flow region. Auger-hole measurements were made to calculate the hydraulic conductivity of the soil above the impervious layer. Its average value was found to be 0.14 m/d. Using Hooghoudt equation, calculate the drain spacing. (10 marks)