EGERTON UNIVERSITY

UNIVERSITY EXAMINATIONS

NJORO CAMPUS

SECOND SEMESTER 2011/2012

FIFTH YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN AGRICULTURAL ENGINEERING

AGEN 555: IRRIGATION AND DRAINAGE ENGINEERING II

STREAM: 2007 (Y5) AGEN **TIME:** 2 hours

DAY/TIME: Monday, 8.30 – 11.30 A.M. **DATE:** 08/05/2012

INSTRUCTIONS:

1. The paper consists of **SIX (6)** questions.
2. Answer **ALL in Section A** and **ANY THREE** from **Section B**.
3. Marks for each question are shown in parenthesis.
4. Use neat and clear sketches where necessary.
5. Aid material for the exam is given at the end of the paper.
6. **EACH QUESTION SHOULD BE STARTED ON A NEW PAGE.**

SECTION A: ATTEMPT ALL QUESTIONS

QUESTION ONE

(a) Briefly describe the unique features of a sprinkler system that makes it ideal for irrigation in most situations.

(b) Briefly describe a Semi-Portable Sprinkler irrigation system, and show reasons why it is considered the ideal system in certain situations.

(c) Briefly describe the most important components of furrow irrigation design.

(d) Briefly describe the components of total dynamic head (TDH) that need to be delivered by the pump during the operation of sprinkler irrigation.

(e) Briefly describe the freeboard requirements that must be met in a drainage ditch for the maintenance of water level. **(20 marks)**

QUESTION TWO

A steel pipe mainline is being designed to deliver a discharge of 63 l/s at a head of 35 m of water to a sprinkler irrigation project located 3050 m from the source. The mainline is to be laid on a level grade. Assume the useful life of the pipes is 20 years and that it will have no salvage value. Money to implement the project will be borrowed from the bank at an interest rate of 5 percent. The pump costs K£ 80.43 per kW, while the energy cost for operating the system is KSh. 10 per kWh. The system will be operated for 1500 hours per year. The pipe costs are given in the following table.

Pipe Diameter (mm) 1	Cost per metre (K£) 2	Total Head (m) 3	Cost of Pump (K£) 4	Annual Capital Cost (K£) 5	Annual Energy Cost (K£) 6	Total Annual Cost (K£) 7
101.6 (4″)	6.56					
152.4 (6″	6.18					
203.2 (8″)	15.58					
254.0 (10″)	24.27					
304.8 (12″)	33.96					

Complete the table above and select the most economical pipe assuming a Hazen-Williams C-value of 140 for the steel pipe and a pumping plant efficiency of 80 percent. **(20 marks)**

SECTION B: ATTEMPT ANY THREE (3) QUESTIONS

QUESTION THREE

A 76.2 mm diameter aluminium lateral pipe has been designed for a sprinkler irrigation system. The lateral carries 30 sprinklers spaced at 18 meters; with the first sprinkler located one full sprinkler spacing from the entrance to the sub-main. Water entering the lateral from the sub-main is maintained at a pressure head of 30 m corresponding to a design sprinkler discharge of 0.16 l/s. Assuming the field surface is level and that the friction factor C for aluminium is 140, determine the following:

(a) The required lateral discharge, l/s.

(b) The head loss due to friction for a through flow pipe of equivalent diameter to the lateral, m.

(c) The actual head loss in the lateral pipe, m

(d) The last sprinkler discharge, l/s

(e) The pressure loss due to velocity at the entrance to the lateral, m/s **(10 marks)**

QUESTION FOUR

A typical tree orchard is to be developed on a farm with dimensions of 250 m by 450 m. The orchards will be irrigated using drip irrigation system so that each tree is served by four emitters. The water source for the system is a 20 m deep well located in the centre of the farm. The following design conditions based on peak period water requirement at full tree maturity are specified.

- Tree spacing = 4 m by 5 m
- Operating pressure head for the emitter = 10 m
- Maximum pressure variation between the 2 critical emitters = 20%
- Distribution pattern efficiency = 92%
- System operating time = 18 hrs/day
- Cost of electric energy = KSh. 10/kWh
- Peak period crop water requirement = 5 mm/day

(a) Show a sketch of the farm layout with the system in place. **(5 marks)**

(b) Determine the following parameters:

(i) Number of trees planted on the farm

(ii) Discharge per emitter (l/s)

(iii) Discharge requirement from the well (l/s)

(iv) Size of 80 percent efficiency submersible pump required to operate the system (kW)

(v) Monthly cost of operating the system (KSh.) **(5 marks)**

QUESTION FIVE

(a) Draw a schematic diagram of surface irrigation phenomenon and define the terms used. **(6 marks)**

(b) Assuming that for a given soil where surface irrigation is being practised, the empirical constant for the Kostiakov equation with depth in centimetres and time in minutes have been determined as K = 0.7 and c = 0.21. Assume that 10% deep percolation is acceptable to the management. If the net irrigation requirements, IR_N, is 8 cm, determine:

(i) Net time of irrigation. **(3 marks)**

(ii) Advance time required for water to reach the lower end of the field. **(1 mark)**

QUESTION SIX

(a) Determine the size of a smooth concrete collector drain pipe laid on a grade of 0.1 percent which is expected to convey drain water uniformly, from a 20 ha plot drained by field drains, designed for a drainage coefficient of 5 mm/day.

(b) Determine the size of the collector drain pipe in **(a)** above if the water flow from the field drains changed from uniform to non uniform.

(c) Determine the expected size of the collector drain in **(a)** above if it was changed from smooth to corrugated PVC pipe.

(d) Determine the expected size of the collector drain pipe in **(a)** above if the drainage coefficient was changed from 5 mm/day to 13 mm/day.

(e) Determine the expected size of the collector drain pipe in **(a)** above if it was realigned to follow a grade of 0.4 percent **(10 marks)**

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