MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 511: PUBLIC HEALTH ENGINEERING IV

DATE: **TIME:**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Service levels are the standards of supply which a water undertaking affords its customers. In connection with this discuss the three principal levels of service which relate to the performance of distribution system. (6 marks)

b) A spun precast concrete pipe is required to carry a storm wastewater discharge of $0.95m^3/s$ when laid at a gradient of 0.002325. Determine its size. Relevant chart is provided $k = 6x10^{-4}m$ (10 marks)

c) Give the categories of wetlands with respect to the state of wetland plants (macrophytes) used and/or grown (4 marks)

d) With respect to flow of wastewater, discuss the types of constructed wetlands available (4 marks)

e) What are the limitations of submerged vegetation in the performance of constructed wetlands for wastewater treatment. (6 marks)

QUESTION ONE (20 MARKS)

a) Project implementation is carried out after a series of stages in the planning phase. One of the key stages is feasibility study. The most feasible option or options are carried forward to preliminary design and ultimately detailed design. A number of methods are used at the feasibility study stage in cost comparison of capital projects whose implementation is to be phased. Consider 3 of these methods and give a comparative analysis. (10 marks)

b) Gravity mains remain to be the most economical way of conveying water, often in bulk and as such certain key principles are followed in their design. By way of a discussion show why these principles are normally followed. Your discussion should be guided by the key elements or components of a gravity main and the principle or principles guiding the design of each element. (10 marks)

QUESTION THREE (20 MARKS)

A rising main is to convey an average flow of 833.3 m^3/h and a maximum of 937.5m^3/h against a static lift of 0.055km through 1.6 x10^4 m of main. Using annual costs, compare the cost of using 0.5m, 0.6m and 0.7m diameter pipes given the following information:

Costs are: pipeline Ksh 35 per mm diameter per m laid in rural conditions; pumps Ksh 3000 per kW installed with 50% standby required; power Ksh 4.5 pence/kWh. Capital repayment charges assumed 12%, and friction coefficient of the pipeline k = 0.6 mm and water viscosity at 15^0C in the Colebrook-White formula.

QUESTION FOUR (20 MARKS)

a) Describe the principles followed in the design of a gravity main for water supply. List the key elements of the main. (5 marks)

b) The pipelines of a distribution system can be divided into three functional categories. State these categories and discuss their design requirement with the respect to the consumption demand they are to convey. (15 marks)

QUESTION FIVE (20 MARKS)

a) By use of a sketch, describe the components of a constructed wetland with horizontal sub-surface flow (5 marks)

b) Calculate the flow to be conveyed by each category of pipeline identified in (4b) above after estimating the water demand for a city of 200,000 people. Assume the average consumption rate is 171 litres per capita per day and use the flow ratios given in Table 1 for estimating the flow in each category of pipeline . (15 marks)

Table 1: Flow Ratios with respect to Average Daily Demand

Flow ratio	*Range*	*Average*
Peak daily demand : average daily demand	1.5:1 to 3.5:1	2.0:1
Peak hourly demand : average daily demand	2:1 to 7.0:1	4.5:1
Minimum hourly demand : average daily demand	0.25: to 0.5:1	NA