MACHAKOS UNIVERSITY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR BACHELOR IN CIVIL ENGINEERING

ECV303: PUBLIC HEALTH ENGINEERING I

Date 9/3/2023 **Time: 2:00 – 4:00 PM**

INSTRUCTIONS TO CANDIDATES

(i) ATTEMPT QUESTION 1 ANY TWO QUESTIONS

(ii) REASONABLE ASSUMPTIONS SHOULD BE MADE WHERE NECESSARY

Question 1

i) State 5 basic water quality requirements for drinking water giving a reason (s) for each requirement **(5mks)**

ii) Sedimentation is the separation of suspended particles that are heavier than water by gravitation settling. Give 5 water and wastewater treatment processes where this operation is used. **(5mks)**

iii) Discuss the rationale behind the consideration of safe yield for rivers and streams as sources of water supply schemes **(5mks)**

iv) A small community water supply scheme is considering rainwater harvesting as the source of the supply. Design the roof catchment area required for a discharge of 500litres/day if the 90% probability annual rainfall for the area has been estimated by the meteorological department to be 1000mm (15mks)

Question 2

i) Aeration occasionally is required in water treatment. Briefly show when and where this becomes necessary. Hence or otherwise give the conditions necessary for its effectiveness in water treatment and other associated benefits accruing from the aeration operation. **(10mks)**

ii) Show that when particles settle discretely in a sedimentation basin, the particle settling velocity can be obtained by the equation below, and the basin can be designed to remove a specific size particle. **(10mks)**

$$v_s = \left[\frac{4g(\rho_s - \rho)d}{3\ C_D\rho}\right]^{1/2}$$

Where;
v_s= settling velocity
g= gravitational acceleration
ρ_s= density of particle
ρ=fluid density
C_D= drag coefficient
d=diameter of particle

Question 3

i) Coagulation and flocculation are essential processes in the treatment of most surface waters. The two processes operating in conjunction with solid-liquid separation processes are designed to remove a number of impurities from raw water. List 5 of these impurities and describe the mechanisms involved in the removals. **(10mks)**

ii) Discuss the characteristics and properties that inorganic coagulants must exhibit for effective coagulation operation. **(5mks)**

iii) pH and dose of coagulants is critical in the optimization of the coagulation operation. Briefly outline the procedure used in water treatment works to determine the most suitable dose and pH for coagulation efficiency (5mks)

Question 4

i) Disinfection is used in water treatment to reduce pathogens to an acceptable level. In the world, five agents have found common use in disinfecting drinking water. List these disinfectants and name the 3 categories of human enteric pathogens for which disinfection is necessary **(8mks)**
ii) Discuss 7 factors relating to the disinfection efficiency of chlorine **(7mks)**

iii) Migingo Town has an existing horizontal –flow sedimentation tank with an overflow rate of $0.708 m^3/h.m^2$. What percentage removal should be expected for each of the following particle settling velocities in an ideal sedimentation tank: 0.01cm/s, 0.02cm/s and 0.1cm/s. **(5mks)**

Question 5

i) You have been tasked as a Consulting Engineer to design a water supply scheme for a high-class housing suburb in Wote town and the design life of your system is to end in the year 2030. The demand for the suburb is described purely as residential. The population in this section of town has been obtained by census every 10 years by the Kenya National Bureau of Statistics as tabulated below. Calculate the initial, future and ultimate water demand using 2010 as the initial (base year). The design population in the town should be estimated using geometric growth projection **(10mks)**

Year	Population
1930	125000
1940	150000
1950	150000
1960	185000
1970	185000
1980	210000
1990	280000
2000	320000

ii) Settled water turbidity is generally in the range from 1 to 10 NTU with a typical value being 2 NTU. Because these levels of turbidity interfere with the subsequent disinfection processes, the turbidity must be reduced. With the aid of sketches, discuss, in sufficient detail, the process of filtration in a rapid sand filter. How does rapid sand filtration differ from slow sand filtration? **(10mks)**

CONSUMER	UNIT	***RURAL AREAS***			URBAN AREAS		
		High potential	Medium potential	Low potential	High Class Housing	Medium Class Housing	Low Class Housing
People with individual connections	1/head/ day	60	50	40	250	150	75
People without connections	1/head/ day	20	14	10	-	-	20
Livestock unit	1/head/ day	50			-		
Boarding schools	1/head/ day	50					
Day schools with WC without WC	1/head/ day	25 5					
Hospitals Regional District other	1/bed/ day	400) 200) 100)			+ 20 1 per outpatient and day (minimum 5000 1/day)		
Dispensary and Health Centre	1/day	5000					
Hotels High Class Medium Class Low Class	1/bed/ day	600 300 50					
Administrative offices	1/head/ day	25					
Bars	1/day	500					
Shops	1/da	100					
Unspecified industry	1/ha/day				20,000		
Coffee pulping factories	1/kg	25 (when recirculation of water is used).					