



MACHAKOS UNIVERSITY
UNIVERSITY EXAMINATIONS 2024/2025
SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING
FIFTH YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF
SCIENCE IN CIVIL ENGINEERING

ECV 506: PUBLIC HEALTH ENGINEERING III

Date:

Time :

INSTRUCTIONS

- *This paper comprises of **FIVE** questions. Answer **THREE** questions*
- *Question one is **Compulsory** and carries 30 marks*
- *Answer any other **TWO** questions*

Question 1

- (i) Wastewater must first be treated to remove the bulk of contaminants to meet the requirements for disposal consistent with environmental regulations. Disposal can be by reuse, by discharge to surface waters, by injection or percolation to ground waters or by evaporation to the atmosphere. By use of a flow chart discuss the process of wastewater treatment in a conventional treatment system **(15mks)**
- (ii) Why is flow measurement important in the design and operation of wastewater treatment plants (WWTPs)? Give 2 ways in which flow measurement is accomplished **(3mks)**
- (iii) The unit operations that are placed at the upstream end of the wastewater treatment plant (WWTP) are referred to as headworks or preliminary treatment. Preliminary treatment typically serves three important functions. State and explain these functions **(6mks)**

- (ii) Discuss the main pathways of Biological Oxygen Demand (BOD) removal in biological wastewater treatment **(6mks)**.

Question 2

- (i) Determine the surface overflow rate and horizontal velocity of a grit chamber to remove grit without removing organic material. Assume that grit particles have a diameter of $2 \times 10^{-4} \text{m}$ and a specific gravity of 2.65 and organic material has the same diameter and a specific gravity of 1.20. assume $C_D = 10$ **(10mks)**.
- (ii) Most developing countries within the tropics accomplish wastewater treatment using wastewater stabilization ponds which are also known as lagoons. Design an anaerobic pond for Machakos University community if the daily wastewater flow is 10000m^3 . Assume the tank to be rectangular with the length 3 times the breadth. **(10mks)**

Values for k_v are as shown below and are dependent on temperature.

Temperature ($^{\circ}\text{C}$), T	Volumetric loading ($\text{g/m}^3\text{d}$)	BOD removal (%)
<10	100	40
10-20	20T-100	$2T + 20$
>20	300	60

Question 3

Design a coarse screen and determine the headloss through the rack given the following information:

Peak design wet weather flow= $0.6 \text{m}^3/\text{s}$

Velocity through rack at peak wet weather flow= 0.89m/s

Velocity through rack at maximum design dry weather flow= 0.59m/s

Angle of inclination of screen= 60°

Upstream depth of wastewater= 1.1m

(20mks)

Question 4

A wastewater treatment plant uses rectangular sedimentation tanks for primary clarification. The average design flow is $14,000\text{m}^3/\text{d}$, with a peaking factor of 2.5. Two tanks are used. The length, width, and depth are 24m, 7m and 4m respectively. Single effluent weirs are provided at the outlet zone. Calculate the surface overflow rate, detention time and weir loading rates for the design flow. What happens at peak flow conditions? **(20mks)**

Question 5

- (i) The procedures for treatment and disposal of sludge generated at the wastewater treatment plant are a function of the raw wastewater characteristics, individual treatment processes, chemicals usage, local regulations, and numerous site-specific conditions. Discuss 5 categories of Sludge-handling processes **(5mks)**.
- (ii) With the aid of a sketch describe the basic components of an activated sludge reactor. Why is it called activated sludge? **(3mks)**
- (iii) What is the major difference between suspended growth and attached growth processes? **(2mks)**
- (iii) Design a secondary wastewater clarifier given the following information
 - A circular sedimentation tank
 - Minimum detention time of 1/6 days
 - Maximum overflow rate of $2000\text{ m}^3/100\text{m}^2.\text{d}$.

Determine the required diameter of the tank and the side water depth (SWD) if the average flow rate through the tank is $6 \times 10^6\text{ l/d}$ **(10mks)**

TABLE 1.3 Viscosities of Water and Air

Temperature (°C)	Water		Air	
	Viscosity (μ) N·sec/m ²	Kinematic Viscosity (ν) m ² /sec	Viscosity (μ) N·sec/m ²	Kinematic Viscosity (ν) m ² /sec
0	1.781×10^{-3}	1.785×10^{-6}	1.717×10^{-5}	1.329×10^{-5}
5	1.518×10^{-3}	1.519×10^{-6}	1.741×10^{-5}	1.371×10^{-5}
10	1.307×10^{-3}	1.306×10^{-6}	1.767×10^{-5}	1.417×10^{-5}
15	1.139×10^{-3}	1.139×10^{-6}	1.793×10^{-5}	1.463×10^{-5}
20	1.002×10^{-3}	1.003×10^{-6}	1.817×10^{-5}	1.509×10^{-5}
25	0.890×10^{-3}	0.893×10^{-6}	1.840×10^{-5}	1.555×10^{-5}
30	0.798×10^{-3}	0.800×10^{-6}	1.864×10^{-5}	1.601×10^{-5}
40	0.653×10^{-3}	0.658×10^{-6}	1.910×10^{-5}	1.695×10^{-5}
50	0.547×10^{-3}	0.553×10^{-6}	1.954×10^{-5}	1.794×10^{-5}
60	0.466×10^{-3}	0.474×10^{-6}	2.001×10^{-5}	1.886×10^{-5}
70	0.404×10^{-3}	0.413×10^{-6}	2.044×10^{-5}	1.986×10^{-5}
80	0.354×10^{-3}	0.364×10^{-6}	2.088×10^{-5}	2.087×10^{-5}
90	0.315×10^{-3}	0.326×10^{-6}	2.131×10^{-5}	2.193×10^{-5}
100	0.282×10^{-3}	0.294×10^{-6}	2.174×10^{-5}	2.302×10^{-5}