MACHAKOS UNIVERSITY
University examinations 2022/2023
SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FIFTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR BACHELOR IN CIVIL ENGINEERING

ECV 506: PUBLIC HEALTH ENGINEERING III

Date 7/3/2023 **time 2:00 – 4:00 PM**

INSTRUCTIONS

- *This paper comprises of five questions. Answer **three** questions*
- *Question one is **compulsory** and carry 30 marks*
- *Answer any other **two** questions*
- *Reasonable assumptions should be made where necessary*

Question 1

(i) Screening is an important operation in wastewater treatment with the sole purpose of removing large and untreatable solid matter. It is normally undertaken in 2 steps that include coarse and fine screening. Discuss, in sufficient detail, the design considerations for coarse screens (10mks)

(ii) 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) In a horizontal-flow grit chamber, to assure removal of the grit and scour of organic matter that settles, three conditions must be met. Evaluate the 3 conditions (6mks)

(iii) Discuss the main pathways of Biological Oxygen Demand (BOD) removal in biological wastewater treatment **(8mks)**.

Question 2

(i) Using Newton's equation and Camp's scour equation, demonstrate that a grit particle with a diameter of 200 μm and a specific gravity of 2.65 results in a design overflow rate of 0.021 m/s and a horizontal velocity greater than 0.056 m/s and less than 0.23 m/s for an horizontal flow grit chamber if the organic particles

of the same size have a specific gravity of 1.10. Assume $\beta = 0.06$ and $f = 0.03$ **(10mks).**

(ii) Most developing countries within the tropics accomplish wastewater treatment using wastewater stabilization ponds which are also known as lagoons. Discuss the rationale behind this. Hence discuss the types of ponds based on the type of processes occurring within the ponds **(10mks)**

Question 3

The designed hourly average flow of a municipal wastewater plant is $0.438 m^3/s$. Design a grit chamber where the detention time of the peak flow rate is 4.0 minutes. Assume a peak factor of 3.0 and use two chambers for purposes of maintenance. Consider a rectangular orientation with a depth-width ratio of 1.5:1.

(20mks)

Question 4

(i) The bulk of suspended solids which enter a wastewater treatment plant and the waste solids generated in biological treatment result into sludge. Discuss the importance of sludge treatment and management in a WWTP. Hence list and discuss five sludge conditioning processes **(10mks)**

(ii) 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 $m^3/100m^2.d$.

Determine the required diameter of the tank and the side water depth (SWD) if the average flow rate through the tank is $6x10^6$ l/d **(10mks)**

Question 5

(i) Define solid waste and state the factors that influence its generation? **(10mks).**

(ii) Any system employed to process solid waste must have the inherent flexibility to cope with its varying character. There are myriad influences of varying intensity that

continually alter the quantity, composition, and physical and chemical character of the material. Discuss three purposes of waste characterization **(10mks).**