COURSE CODE: CVE 421

COURSE TITLE: WASTEWATER ENGINEERING

NUMBER OF UNITS: 02

COURSE DURATION: 2 hours contact time per week

COURSE DETAILS:

Course Coordinator: Engr. Dr. Adedayo A. BADEJO
Email: dayo_badejo@yahoo.com
Office Location: Civil Engineering Building
Other Lectures:

COURSE CONTENT:

Objectives of waste water treatment. Waste water collection – sources, quantity of wastewater, sewage systems, sewer appurtenances. On outline of the biochemistry of water and waste – bacteria and their enzymes. Aerobic and anaerobic processes, oxygen demand and strength. Waste water treatment – theory and design of different stages of sewage treatment plant; trickling filters, activated sludge, texture ratio channel slope, total fall (relief) stream classification and other features. Soil and vegetation features of watershed with relation to other characteristics and water yield and water quality.

Hydrologic Study of Watershed:

Hydrological data collection from watershed. Watershed analysis and water research methods; single, paired and multiple, watershed methods, calibration of watershed. Analysis, interpretation and application of watershed hydrological data.

Aspects of Watershed Management:

Impact of watershed management of water yield and water quality. Land use and water use interaction. Principles of range and forest management for water and soil conservation. Curative, protective and administrative measures. Manipulations of vegetation cover for water yield management.

COURSE REQUIREMENTS:

This course is a compulsory course for Civil Engineering students. Students are expected to participate in all the course activities and have a minimum of 75% attendance to be able to write the final examination.

READING LIST:

Wastewater Engineering (2003) Fourth Edition by Ruth F. Weiner. Butter Heinemann, Elsevier Science USA.
Wastewater Engineering. Treatment and Reuse (2004) Fourth Edition by Metcalf and Eddy. Tata McGraw-Hill Edition New Delhi

LECTURE NOTES:

Introduction

- The liquid waste- wastewater is essentially the water supply of the community after it has been used in a variety of applications
- Wastewater may be defined from the standpoint of sources of generation as a combination of the liquid or water-carried wastes removed from institution, commercial and industrial establishments
- When this wastewater accumulates and is allowed to go septic, the decomposition of the organic matter it contains will lead to nuisance conditions
- The immediate and nuisance free removal of wastewater from its sources of generation followed by treatment, reuse or disposal into the environment is necessary to protect public health and the environment.
- Wastewater engineering is that branch of environmental engineering in which the basic principles of science and engineering are applied to solve the issues associated with the treatment and reuse of wastewater.

The ultimate goal of wastewater engineering is the protection of public health in a manner commensurate with environmental, economic, social and political concerns

Basis Terminologies

- Biosolids
- Characteristics
- Composition
- Constituent
- Disinfection
- Non-point source
- Point source
- Reclamation
- Sludge

Sewage

- Domestic or sanitary wastewater refers to liquid discharged from residential, business buildings and institutions. Industrial wastewater is discharged from manufacturing plants.
- Municipal wastewater is the general term applied to the liquid collected in sanitary sewers and treated in municipal plants
- Domestic sewage is composed of human body waste and sullage which is the wastewater resulting from personal washing, laundry, and cleaning of kitchen utensils

Composition of sewage

- Sewage consist of about 99.9% water and 0.1 % solids, the solids are either organic or inorganic. The organic solids consist of about 65% protein, 25% carbohydrate and 10% fats.
- Faeces and to a less extent urine contain millions of intestinal bacteria and small numbers of other organisms
- The organic mater contributed per person per day in domestic wastewater is approximately 110g of suspended solids and 90g of BOD in communities where substantial portion of the household kitchen waste is discharged to the sewer system

Collection of Sewage

- Sewage is conveyed in pipes known as sewers from its place of production to its place of treatment and disposal.
- The sewers are usually in network of underground conduits. They are either of the separate or combined system
- Pattern of sewer network
- Type of system
- Street layout
- Topography
- Location and type of treatment works

Wastewater Treatment

- The major categories of treatment steps include:
- Preliminary treatment: this removes materials that could damage plant equipment or would occupy treatment capacity without being treated.
- Primary treatment: this removes settleable and floatable solids
- Secondary treatment: this removes BOD, dissolved and colloidal suspended organic matter by biological action.
- Advanced wastewater treatment: this uses physical, chemical and biological processes to remove additional BOD, Solids and nutrients.
- Disinfection: this removes microorganisms to eliminate or reduce the possibility of disease when the flow is discharged
- Sludge treatment: this stabilizes the solids removed from wastewater during treatment, inactivates pathogenic organisms and reduces the volume of the sludge.

Wastewater Treatment

- Preaeration: Often adopted to achieve and maintain an aerobic state, strip off hydrogen sulphide, agitate solids, and reduce biochemical oxygen demand
- Chemical addition: The purpose of adding chemicals is to improve settling, reduce odour, neutralize acids or bases, reduce corrosion, reduce BOD, improve solids and gases removal, reduce loading on the plant, add or remove nutrients and aid downstream processes.
- Equalization: This helps to reduce or remove the wide swings in flow rates normally associated with wastewater treatment plant loading, it minimizes the impact of storm water flows.

- Primary treatment: The purpose primary sedimentation or clarification is to remove settleable organic and floatable solids. Normally, each primary clarification unit can be expected to remove 90% settleable solids, 40% to 70% TSS and 25-35% BOD
- Process Description: Wastewater enters a settling tank, solids that are heavier than water settle to the bottom while those lighter than water floats on top. Settled solids are removed as sludge and floating solids are removed as scum. Detention time, temperature, tank design and condition of the equipment controls the efficiency of the process.
- Types of sedimentation tank
- Septic tank
- Imhoff tank
- Plain settling tank or clarifiers

Measuring Plant Performance

- The performance efficiency or percent removal is always used to evaluate how a plant or treatment unit process is operating.

$$= \frac{\text{Influent concentration} - \text{effluent concentration}}{\text{Influent concentration}} \times 100$$

$$\% \text{ volatile matter reduction in sludge} = \frac{(\% Vm_{in} - \% Vm_{out}) \times 100}{\{\% VM_{in} - (\% VM_{in} \times \% VM_{out})\}}$$

- Hydraulic Detention Time: This refers to the avearge length of time (theoretical time) a drop of water, wastewater or suspended particles remain in a tank or channel

$$= \frac{\text{water or wastewater in tank}}{\text{flow rate through the tank}} = \frac{\text{volume}}{\text{flowrate}}$$