Reg. No									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

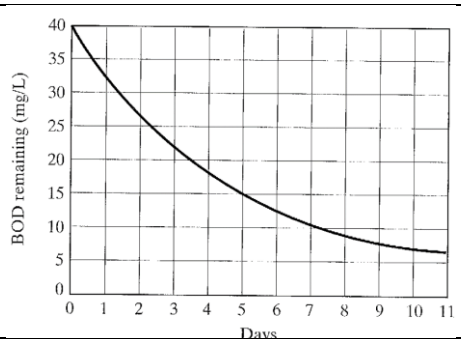
VI SEMESTER B.TECH. EXTERNAL EXAMINATIONS MAY 2022

SUBJECT: MICROBIAL TREATMENT OF WASTEWATER [BIO 4053]

Instructions to Candidates:

- Answer ALL the questions & missing data may be suitable assumed

<table>
<tr><th>Q.NO</th><th></th><th>Mark</th><th>CO</th><th>BTL</th></tr>
<tr><td>1A.</td><td>Determine the activity coefficients for the mono and divalent ions in the wastewater for the data given below. Using the value of the activity coefficient for a divalent ion, estimate the equilibrium concentration of calcium in solution needed to satisfy the solubility product for calcium carbonate ($CaCO_3$) at 25°C. The value of the solubility product constant K_{sp} at 25°C is 5 X 10^{-9}.
<table>
<tr><th>Cation</th><th>Concentration(ppm)</th><th>Anion</th><th>Concentration(ppm)</th></tr>
<tr><td>Ca^{2+}</td><td>29.9</td><td>HCO_3^-</td><td>167.0</td></tr>
<tr><td>Mg^{2+}</td><td>139.8</td><td>SO_4^{2-}</td><td>78.0</td></tr>
<tr><td>Na^+</td><td>349.8</td><td>Cl^-</td><td>46.0</td></tr>
<tr><td>K^+</td><td>410.4</td><td>NO_3^-</td><td>128.4</td></tr>
</table></td><td>4</td><td>1</td><td>4</td></tr>
<tr><td>1B.</td><td>The following test results were obtained for a wastewater sample taken at the headworks to a wastewater treatment plant. All of the tests were performed using a sample size of 50 mL. Determine the concentration of total solids, total volatile solids, suspended solids, volatile suspended solids, total dissolved solids and total volatile dissolved solids in mg/L. The samples used in the solids analyses were all either, dried, or ignited to constant weight
Tare mass of evaporating dish = 53.5433 g
Mass of evaporating dish plus residue after evaporation at 105°C = 53.5794 g
Mass of evaporating dish plus residue after ignition at 550°C = 53.5625 g
Tare mass of Whatman GF/C filter and reside after drying at 105°C = 1.5433 g
Mass of Whatman GF/C filter and residue after drying at 105°C = 1.5554 g
Mass of Whatman GF/C filter and residue ignition at 550°C = 1.5476 g</td><td>4</td><td>1</td><td>3</td></tr>
<tr><td>1C.</td><td>Discuss the influence and impact of emerging pollutants in wastewater and environment.</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>2A.</td><td>If a ground water contains H_2S at concentration of 2 mg/l, determine the concentration of H_2S in head space of a closed tank containing the ground water at at 20^{o}C. Given that for H_2S, Henry's constant (H) is equal to 5.15×10^2 atm at 20^{o}C.</td><td>2</td><td>1</td><td>4</td></tr>
<tr><td>2B.</td><td>The time profile of BOD of a sample collected from a wastewater treatment plant.
a. Calculate the ultimate BOD (Lo)?
b. What is the five-day BOD?
c. What is Lt for 7 days?</td><td>3</td><td>2</td><td>3</td></tr>
</table>

<table>
<tr><td></td><td> 
</td><td></td><td></td><td></td></tr>
<tr><td>2C.</td><td>Compute k and UBOD using Least square and Fujimoto method for the following BOD data reported for a stream receiving some treated effluent.
<table>
<tr><td>Time (d)</td><td>2</td><td>4</td><td>6</td><td>8</td><td>10</td></tr>
<tr><td>BOD (mg/L)</td><td>11</td><td>18</td><td>22</td><td>24</td><td>26</td></tr>
</table></td><td>5</td><td>2</td><td>4</td></tr>
<tr><td>3A.</td><td>Explain the Most probable number analysis for the quantification of total coliform bacteria using presumptive, confirmed, and completed test.</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>3B.</td><td>Determine graphically the 96-h LC_{50} values in percent by volume for the following toxicity test data obtained using flathead minnows.
<table>
<tr><th>Concentration of waste, % by volume</th><th>No. of Test animals</th><th>No. of Test animals dead after 48 h</th><th>96h</th></tr>
<tr><td>60</td><td>20</td><td>16</td><td>20</td></tr>
<tr><td>40</td><td>20</td><td>12</td><td>18</td></tr>
<tr><td>20</td><td>20</td><td>8</td><td>16</td></tr>
<tr><td>10</td><td>20</td><td>4</td><td>12</td></tr>
<tr><td>5</td><td>20</td><td>0</td><td>6</td></tr>
<tr><td>2</td><td>20</td><td>0</td><td>2</td></tr>
</table></td><td>4</td><td>3</td><td>4</td></tr>
<tr><td>3C.</td><td>A municipal wastewater treatment plant is discharging secondary effluent into a river. The dilution received at the boundary of the mixing zone at minimum 3-year dry weather flow condition is 48:1. Acute and chronic toxicity tests were conducted on three freshwater species to eliminate the effect of sensitivities of test species to the plant effluent. The acute toxicity were conducted over a 96 hours period (control survival is 100% and the LC50 was found to be 7.3). The chronic end point observed for 10 days (control survival is 100% and NOEC is 1.1). Determine the toxicity compliance</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>4A.</td><td>Determine the rise in temperature for the aerobic stabilization of raw sewage sludge, if the initial dry matter content is around 36 g/L (average organic dry matter content of sewage sludge) and the biodegradability of 50% within the residence time in the sludge reactor.</td><td>`3</td><td>4</td><td>3</td></tr>
<tr><td>4B.</td><td>Illustrate and discuss the steps involved in anaerobic degradation of carbohydrate and protein.</td><td>3</td><td>4</td><td>2</td></tr>
<tr><td>4C.</td><td>For glutamine ($C_5H_7NO_2$), use the Buswell equation and determine theoretically:
a) the gas composition (% carbon dioxide and % methane) produced and
b) the volume of methane produced from 1 kg of the biomolecules at NTP.</td><td>4</td><td>4</td><td>3</td></tr>
<tr><td>5A.</td><td>Explain the simultaneous nitrification-denitrification process used in the wastewater treatment plant</td><td>3</td><td>5</td><td>2</td></tr>
<tr><td>5B.</td><td>List the design criteria and dimensions of the UASB reactor</td><td>4</td><td>5</td><td>2</td></tr>
<tr><td>5C.</td><td>Compare and contrast the different anaerobic attached film reactor used for treating the wastewater.</td><td>3</td><td>5</td><td>2</td></tr>
<tr><td colspan="5">CO: Course Outcome; BLOOM TAXONOMY LEVEL: 1-Remember, 2-Understand, 3-Apply, 4-Analyze, 5-Evaluate, 6-Create</td></tr>
</table>