Reg. No									

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VI SEMESTER B.TECH. EXTERNAL EXAMINATIONS APRIL 2019
SUBJECT: MICROBIAL TREATMENT OF WASTEWATER [BIO 4003]

Date of Exam: **30/04/2019** Time of Exam: **2.00 PM – 5.00 PM** Max. Marks: **50**

Instructions to Candidates:

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

1A. 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}. **5**

Cation	Concentration(ppm)	Anion	Concentration(ppm)
Ca^{2+}	29.9	HCO_3^-	167.0
Mg^{2+}	139.8	SO_4^{2-}	78.0
Na^+	349.8	Cl^-	46.0
K^+	410.4	NO_3^-	128.4

1B. A well-mixed 25 mL of raw wastewater is used for TS analyses. A well-mixed 50 mL of raw wastewater is used for SS analyses. The laboratory results are as follows: **5**
Tare wt of evaporating dish = 42.2361 g
Wt of dish plus residue after evaporation at 105°C = 42.4986 g
Wt of dish plus residue after ignition at 550 °C = 42.4863 g
Tare wt of filter plus Gooch crucible = 21.5308 g
Wt of residue and filter plus crucible after drying at 105 °C = 21.5447 g
Wt of residue and filter plus crucible after ignition at 550 °C = 21.5349 g
Compute the concentrations of TS, VS, FS, TSS, VSS, FSS.

2A. Assuming 0.1 mM of glutamic acid ($C_5H_9O_4N$) is used in the following stoichiometric reactions, calculate the NBOD of glutamic acid. **2**

$$C_5H_9O_4N + 4.5O_2 \longrightarrow 5CO_2 + 3H_2O + NH_3$$

$$NH_3 + 2O_2 \longrightarrow NO^{3-} + H^+ + H_2O$$

2B. The time profile (Fig.1) of BOD of a sample collected from a wastewater treatment plant. **3**
a. Calculate the ultimate BOD (Lo)?
b. What is the five-day BOD?
c. What is Lt for 7 days?

2C. The wastewater had a BOD5 equal to a 180 mg/L and a reaction rate k equal to 0.22/day. It also has total Kjedahl nitrogen content (TKN) of 30 mg/L. **5**
a. Find the ultimate carbonaceous oxygen demand (CBOD).
b. Find the ultimate nitrogenous oxygen demand (NBOD).
c. Find the remaining BOD (nitrogenous plus carbonaceous) after five days have elapsed.

<table>
<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></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 rowspan="2">Concentration of waste, % by volume</th><th rowspan="2">No. of Test animals</th><th colspan="2">No. of Test animals' dead after</th></tr>
<tr><th>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></tr>
<tr><td>3C.</td><td>Estimate the amount of heat, surplus sludge and biogas formed during aerobic degradation of 1 mol of glucose (in an activated sludge system at a high BOD loading rate). Write the mass and energy balance for the overall process.</td><td>3</td></tr>
<tr><td>4A.</td><td>For glutamine ($C_5H_{10}N_2O_3$), 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></tr>
<tr><td>4B.</td><td>Illustrate the steps involved in anaerobic degradation of protein.</td><td>2</td></tr>
<tr><td>4C.</td><td>What is the general consideration in selecting aerobic and/or anaerobic processes for degrading the organic matter?</td><td>4</td></tr>
<tr><td>5A.</td><td>Discuss in detail about the design considerations for UASB.</td><td>5</td></tr>
<tr><td>5B.</td><td>Compare and contrast the different anaerobic attached film reactor used for treating the wastewater.</td><td>5</td></tr>
</table>

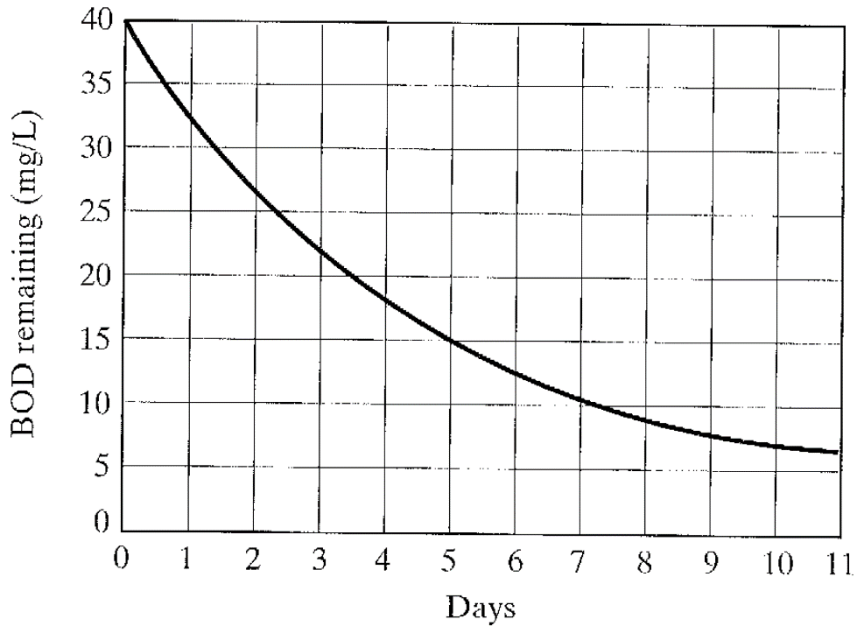

Figure 1