ME (C.E.) 1st SEMESTER FINAL EXAMINATION, 2012-13
Biological Processes in Environmental Engineering (CE 915)

Time Allowed: 3 hrs. **Full Marks: 70**

Answer part A and Part B in a single answer-script.
Assume reasonable data if necessary.
Answers should be brief and to the point.
*Answer **FIVE (5)** questions taking atleast **TWO (2)** from each part.*

PART- A

1) a) How 'BOD' of wastewater is determined in the laboratory?
b) The BOD value of a wastewater was measured at 2 and 7 days and found to be 125 and 225 mg/l respectively. Determine the 5-d value using the first order rate model.
b) Discuss Fujimoto method for determining the BOD rate constant along with its mathematical forms.
c) Calculate the BOD reaction rate constant using the Fujimoto method for the following data.

Time (d)	0	1	2	3	4	5	6	7
BOD (mg/l) at 20 °C	0	65	109	138	158	178	190	200

3+3+5+3=**14**

2) a) State the assumptions in modeling the activated sludge process (ASP).
b) Derive the relationship among MLSS, SRT, HRT, growth yield, decay constant, influent and effluent substrate concentration for conventional (ASP).
b) What aeration tank volume is required to treat a wastewater flow of 1.5 MGD and BODu of 200 mg/l. An extended aeration process is to be used and the pertinent design criteria are as follows:
Biomass concentration = 4000 mg/l $Y_T = 0.5$ $K_d = 0.02\ d^{-1}$ $K = 0.15$ l/mg.d
c) What is sludge volume index (SVI)? What is the importance of SVI? How does it related with biomass concentration in returned sludge?

2+5+3+4=**14**

3) a) Discuss about the procedure for design of secondary sedimentation tank (SST).
b) A column analysis was run to determine the settling characteristics of an activated sludge suspension. The results of the analysis are shown below.

MLSS (mg/l)	1600	2400	3300	3900	4500	5300	6600	8200
Velocity (m/h)	3.0	1.7	1.1	0.70	0.40	0.28	0.11	0.08

The influent concentration of MLSS is 2000 mg/l and the flow rate is 12000 m^3/d. Determine the size of the clarifier that will thicken the solids to 10000 mg/l.
c) Calculate the volume of two stage trickling filter with the following data using NRC equation
Average wastewater flow rate = 50 MLD
Influent BOD_5 = 240 mg/l
Effluent BOD_5 = 25 mg/l
BOD loading rate = 0.9 kg $BOD_5/m^3/d$
Recirculation ratio R_1 and R_2 = 3 and 2 respectively

6+4+4=**14**

4) a) Derive an expression for fraction of soluble BOD remaining in a waste stabilization pond stating the assumptions. How this expression is used for design of pond?
b) A bio-tower composed of a modular plastic material is to be used for secondary treatment of municipal wastewater. The flow from the primary clarifier is 20 MLD with a BOD_5 of 180 mg/l. Two bio-towers are to be used, each with square surface and separated by a common wall. The medium is to have a depth

of 7.0 m and recirculation ratio to be 2.0. Determine the dimensions of the units required to produce an effluent concentration of 30 mg/l (BOD_5). Minimum temperature expected to be 20°C. Given n = 0.5 and k_{20} = 0.1 per min.

c) In an anaerobic standard rate sludge digester, the raw sludge loading rate is 75.0 m^3/d (having 1% consistency). The sludge is known to be about 70% organic and 30% inorganic in nature. Approximately 65% of the organic fraction is converted to liquid and gaseous end products after a period of 35 days. The digested sludge has a solid content of 5% and must be stored for a period of upto 90 days. Determine the volume requirement for a standard rate single stage digester.

5+4+5=**14**

PART – B

5) a) List five requirements that must be complied with in order to obtain reliable BOD data.
   b) List five requirements of a satisfactory dilution water for BOD work.
   c) Why is a seed control needed in the BOD test?
   d) What factors affect the rate of biochemical oxidation in the BOD test?

4+4+3+3= **14**

6) a) Define: (i) Metabolism, (ii) Catabolism, (iii) Anabolism and (iv) endogenous catabolism.
   b) Define: (i) Autotrops, (ii) Heterotrops and (iii) Phototrophs.
   c) What are adaptive enzymes? What role do they play in natural purification processes of bodies of water?
   d) What are the mechanisms known to contribute oxygen to surface water?

4+3+4+3= **14**

7) a) What factors affect the performance of mechanical aerators for oxygen transfer?
   b) List the different types of aerators available to suite various requirements.
   c) Distinguish among the various types of aerated lagoons treating domestic sewage.
   d) What factors affect the pond ecosystem? What strategies are available to a designer for high removal of microorganism in waste stabilization ponds?

3+3+4+4= **14**

8) a) Define θ_c, SRT and sludge age and explain their use in regulating the activated sludge process.
   b) What is the purpose of the F/M ratio? Show the relationship between F/M and θ_c.
   c) Show schematically the pattern of carbon flow in anaerobic digester.
   d) Show the typical energy yielding conversion reaction involved in the anaerobic digestor.

3+4+4+3= **14**
