ME (CE) 1st SEMESTER FINAL EXAMINATION, 2011-12
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.

PART- A
*Answer any **TWO (2)** questions.*

1) a) Derive the relationship among MLSS, SRT, HRT, growth yield, decay constant, influent and effluent substrate concentration for conventional activated sludge process (ASP).

b) Derive the relationship among MLSS, HRT, decay constant, influent and effluent substrate concentration for extended aeration process.

c) For a convention activated sludge process the following data are given:

Design flow = 40 MLD
Influent BOD_5 = 220 mg/l — Effluent BOD_5 = 30 mg/l
Minimum temperature = 18°C — Maximum temperature = 32°C
$\theta_c = 6.5\ d$ — Y = 0.5 — K_d = 0.06/d — MLSS = 3000 mg/l
f = 0.68 — C_S = 7.2 mg/l at 32°C — C_L = 1 mg/l — α = 0.85
Aeration equipment oxygen transfer efficiency under standard condition = 1.8 kg/KWh

Calculate:

(i) aeration tank volume, (ii) excess sludge volume, (iii) sludge recirculation volume, (iv) oxygen requirement and (v) aerator power requirement.

5+3+6=**14**

2) a) Describe different methods of aeration in activated sludge process.

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)	1500	2300	3200	3800	4400	5100	6400	8000
Velocity (m/h)	3.1	1.8	1.2	0.75	0.44	0.30	0.13	0.09

The influent concentration of MLSS is 2500 mg/l and the flow rate is 10000 m^3/d. Determine the size of the clarifier that will thicken the solids to 10000 mg/l.

c) What aeration tank volume is required to treat a wastewater flow of 10 MLD and BOD_u of 200 mg/l. An extended aeration process is to be used and pertinent design criteria are as follows:

X_a = 4000 mg/l — Y_T = 0.5 — K_d = 0.02 per day — S_e = 0.5 mg/l

7+3+4=**14**

3) a) Calculate the volume of two stage trickling filter with the following data using NRC equation

Average wastewater flow rate = 40 MLD
Influent BOD_5 = 220 mg/l
Effluent BOD_5 = 15 mg/l
BOD loading rate = 0.8 kg $BOD_5/m^3/d$
Recirculation ratio R_1 and R_2 = 2 and 1 respectively

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 25 MLD with a BOD_5 of 160 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 6.5 m and recirculation ratio to be 2.5. Determine the dimensions of the units required to produce an effluent concentration of 20 mg/l (BOD_5). Minimum temperature expected to be 15°C. Given n = 0.5 and k_{20} = 0.055 per min.

c) In an anaerobic standard rate sludge digester, the raw sludge loading rate is 77.0 m^3/d (having 1% consistency). The sludge is known to be about 65% organic and 35% inorganic in nature. Approximately 70% of the organic fraction is converted to liquid and gaseous end products after a period of 30 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.

4+4+6=**14**

PART – B

*Answer any **THREE (3)** questions.*

4) a) Define catabolism, anabolism and endogenous catabolism.
b) Classify the microorganisms by sources of energy and carbon, in general.
c) Name the most common methods of quantifying biomass. What external factors may affect the rate of biomass production and food utilization?
d) Distinguish between aerobic, anaerobic and facultative process.

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

5) a) Explain then difference between bulking sludge and raising sludge and what circumstances each to occur?
b) Explain the purpose of the F/M ratio and the relationship between F/M and θ_c.
c) Explain biological nitrification and denitrification either words or with equation.
d) Define SVI and explain its use in the design and operation of the activated sludge plant.

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

6) a) Compare between 'BOD' and 'COD'. Outline the steps in the standard 5-day BOD test.
b) Graphically show the BOD and oxygen equivalent relationship.
c) Discuss the factors that govern the numerical value of the BOD rate constant.
d) Sketch a graph showing the effect of varying rate constant on 5-day BOD if the ultimate BOD is same and the effect on ultimate BOD if the 5-day BOD is the same.

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

7) a) What are the two basic types of sludge digestion units?
b) Show schematically the pattern of carbon flow in anaerobic digestion process.
c) What are the typical energy yielding conversion reactions involved over the sludge compounds in the digestion process? Schematically show the anaerobic digestion process with energy flow.

3+5+6= **14**

8) a) Schematically show the waste treatment process in a facultative pond and its symbiotic relationship with algae, bacterial and others.
b) List the factors that affect the pond ecosystem.
c) What strategies are available to a designer for high removal of microorganism in waste stabilization ponds?
d) Briefly discuss on sulphide production in ponds.

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