INDIAN INSTITUTE OF TECHNOLOGY PATNA
CE 102: Environmental Studies
Final Examination 2015-16 II: CE + CST + EE

Maximum Time: 120 Minutes **Maximum Marks: 40**

Instructions

- Make suitable assumptions wherever necessary.
- Numbers in the parenthesis at the end of each question indicate Maximum Marks.
- Use of notes/reference materials is *not* permitted.
- Use of mobile phone is *not* permitted. Sharing of calculator is *not* permitted.
- Write your name and roll number on the question paper in the space below before proceeding further. ***Do not forget to submit question paper along with answer book.***

Name: _____ **Roll No:** _____

Questions

1. Briefly answer any *five* of the following questions: **(5 × 02)**

(i) Differentiate between limnology and hydrology.
(ii) 'Food web provides more stability to the ecosystem as compared to food chain'. Justify the statement with suitable example.
(iii) Differentiate between conventional sanitation system and ecological sanitation (EcoSan) system in terms of: (a) fresh water requirement, (b) flow of materials including nutrients, (c) degree of pollution, and (d) sustainability.
(iv) Differentiate qualitatively between surface water and ground water based on following characteristics: (a) total dissolved solids, (b) hardness, (c) dissolved oxygen, and (d) presence of microorganisms.
(v) Explain briefly various properties of hazardous waste with examples.
(vi) Assuming theoretical oxygen demand (ThOD) is equivalent and synonymous with chemical oxygen demand (COD), estimate COD of 50 mg/L solution of urea [$CO(NH_2)_2$]. Justify your estimate.

2. A lake is 20 m deep, well-mixed and perfectly circular with a radius of 50 m. At the inlet 2 cubic meters of water enters every second, containing 8 mg NO_3^-/L in snowmelt from the lightning-prone slopes of mountains nearby. Every day the local fisherman remove 40 kg of nitrogen (as N) from the lake in sustainable fish catches, and according to air measurements made the lake emits 250 moles of N_2O and 500 moles of N_2 every day. There are no other sources or sinks of N. Writing appropriate mass balance equation, calculate the concentration of NO_3^- in the water coming out of the lake. **(05)**

3. Stating Dalton's Law of Partial Pressure and Henry's Law, estimate equilibrium dissolved oxygen concentration (in mg/L) in natural surface water free from pollution at 30°C. Assume $(K_H)_{O_2}$ in water at 30°C as 0.89 atm-m^3/mol. **(03)**

4. (a) Drawing schematic/block diagram, briefly describe Nitrogen Cycle.
(b) A sample of air analyzed at 0°C and 1 atm pressure is reported to contain 20 ppm of NO. Determine the equivalent NO concentration in micrograms per cubic meter and milligrams per cubic meter. **(03 + 02)**

5. Draw a typical flow sheet of drinking water treatment plant indicating a typical sequence of unit operations as blocks that are used for the treatment of (i) surface water and (ii) ground water containing 10-20 mg/L of both iron and manganese. **(03)**

6. (a) Calculate the total hardness, carbonate hardness, and non-carbonate hardness (in mg/L as $CaCO_3$) of water (pH = 7) that contains the following ion concentrations: Na^+ = 98 mg/L; Ca^{2+} = 55 mg/L; Mg^{2+} = 18 mg/L; HCO_3^- =250 mg/L; Cl^- = 89 mg/L; SO_4^{2-} = 60 mg/L.

(b) What are the alkalinity-causing species present in natural water? Nitrification involves biological conversion of ammonia (NH_4^+) to first nitrite (NO_2^-) and finally to nitrate (NO_3^-) as per the following complete balanced reaction: $NH_4^+ + 2O_2 \rightarrow NO_3^- + 2H^+ + H_2O$

Justify the statement showing calculation that 'nitrification process involves consumption of alkalinity of 7.14 mg as $CaCO_3$ per mg of NH_4^+-N'.

(c) Assuming ThOD is equivalent and synonymous with COD, estimate COD of 100 mg/L solution of of glycine [$CH_2(NH_2)COOH$] solution using the following assumptions: (i) In the first step, the organic carbon and nitrogen are converted to CO_2 and NH_3, respectively, (ii) In the second and third steps, the ammonia (NH_3) is oxidized sequentially to nitrite and nitrate, and (iii) The ThOD i.e. COD is the sum of the oxygen required for all three steps.

(03 + 02 + 02)

7. (a) Briefly define/explain following terms: (i) hydrologic cycle, (ii) eutrophication, (iii) aerosol and fog, (iv) aerodynamic diameter and $PM_{2.5}$, and (v) photochemical smog.
(b) Briefly explain how food chain and food web will be affected if e-waste is not properly managed.

(05 + 02)

Some Useful Information:

C: 12; H: 1; O: 16; N: 14; S: 32; Na: 23; K: 39; Ca: 40; Mg: 24; Al: 27; Cl: 35.5