M. Sc. in Civil Engineering

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Time: 2:30 PM–4:00 PM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

TERM: MID SEMESTER EXAMINATION — WINTER SEMESTER: 2023-2024
COURSE NO.: CEE 6305 — TIME: 1.5 Hours
COURSE TITLE: Surface Water Quality Modeling — FULL MARKS: 75

There are **3 (Three)** questions. Answer **ALL** questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. Symbols convey their usual meanings. Assume reasonable values for any necessary design data where required.

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1. (a) Define and explain the sources of surface water. Explain notable surface water quality with their standards according to ECR 2023. **(08)**

(b) Explain the importance of developing a Surface Water Quality Model with a suitable example. **(08)**

(c) Explain Fick's 1st Law. Discuss the application of Fick's 2nd Law. **(09)**

2. (a) How do you estimate low flow in any stream? Explain the water balance of a well-mixed lake. **(05)**

(b) Consider a lake with 200×10^6 m^2 of surface area for which the only source is the effluent from a Sewage outfall. The effluent flow rate is 0.6 m^3/s and its phosphorus concentration is 20 mg/L. The lake is also fed by a small stream having 30 m^3/s with 6 g/m^3 of phosphorus. If the phosphorus settling rate is estimated to be 9 m/year, then, (i) estimate the average phosphorus concentration in the lake, (ii) what level of phosphorus removal at the treatment plant would be required to keep the average lake concentration below 0.010 mg/L? **(10)**

(c) A Lake has the following Characteristics: Volume $=1\times10^6$ m^3, river inflow $= 1\times10^6$ m^3/d, and river outflow $= 0.9\times 10^6$ m^3/d. Suppose that a first-order decaying (0.1/day) dissolved pollutant is discharged to this system at a constant rate of mass loading of 1×10^7 g/d. Calculate the lake concentration for two cases, if the discrepancy between inflow and outflow is due to (i) a groundwater loss or (ii) an evaporation loss. **(10)**

3. (a) How you apply the Mass-Transport concept in developing a Surface Water Quality model? **(5)**

(b) Explain the advection and dispersion process with examples. **(5)**

(c) A municipal wastewater treatment plant discharges 0.8 m^3/s of treated effluent having BOD_5 of 50 mg/L and DO of 2.0 mg/L into a stream that has a flow of 0.7 m^3/s and a BOD_5 of 5 mg/L and DO of 8.0 mg/L. The temperature of the river is 22^0C. The deoxygenation constant K_d is 0.21/day at 20^0C. The stream has a depth of 2.1 m and the average stream velocity is 0.17 m/s. **(15)**

(i) Find the critical distance downstream at which DO is a minimum.

(ii) Find the minimum DO.

Supporting Equations:

$$D = \frac{k_1 L_o}{k_2 - k_1}(e^{-k_1 t} - e^{-k_2 t}) + D_o e^{-k_2 t}$$

$$\frac{dD}{dt} = k_1 L_o e^{-k_1 t} - k_2 D = 0$$

$$D_c = \frac{k_1}{k_2} L_o e^{-k_1 t}$$

$$t_c = \frac{1}{k_2 - k_1} \ln\left\{\frac{k_2}{k_1}\left[1 - \frac{D_o(k_2 - k_1)}{k_1 L_o}\right]\right\}$$