BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2023-2024
MID-SEMESTER 2022-23 (OPEN BOOK/NOTES)

COURSE NO.: CE G525 TIME: 90 Min.
COURSE TITLE: Water Resources Planning and Management DATE: 09/10/2023
MAX. MARKS: 25%

Note: (i) Attempt all questions, (ii) Make necessary assumptions, if required.

Q.1 For the function, $z = f(x) = 2x_1^2 + 2x_2^2 - 8x_1 + 12x_2 + 7$, determine the stationary points, obtain the values of the function at these stationary o]points and check them for optimality. [6.0]

Q.2 A 4000 m^3 capacity reactor is used in a water reclamation plant. The influent concentration is 100 mg/L, the effluent concentration is 25 mg/L, and the flow rate through the reactor is 2000 liters/min. (a) What is the first-order rate constant for decay of BOD in the reactor? Assume the reactor can be modeled as a completely mixed flow reactor (CMFR). Report your answer in units per hour. (b) Assume the reactor should be modeled as a plug flow reactor (PFR) with first-order decay, *not* as a CMFR. In that case, what must be the first-order decay rate constant within the PFR reactor? (c) It has been determined that the outlet concentration is too high, so the residence time in the reactor must be doubled. Assuming all other variables remain constant, what must be the volume of the new CMFR? [6.0]

Q.3 A municipal WWTP discharges 0.5 m^3/s of secondary effluent, at a temperature of 25°C, that contains 30 mg/L of ultimate BOD. To meet regulatory requirements, the effluent is aerated to achieve 5.0 mg/L of dissolved oxygen prior to discharge. The stream flow is 3.0 m^3/s and the temperature upstream of the discharge point is 15°C with saturated dissolved oxygen. The background ultimate BOD in the stream is 15.0 mg/L. The reaeration (k_r) and deoxygenation (k_d) rate coefficients are 0.40 d^{-1} and 0.20 d^{-1}, respectively, at 20°C. In-stream standards require a minimum of 7.0 mg/L of DO at all times. Assuming any other necessary data, if required, determine the following:

(a) temperature of the combined wastewater and stream;
(b) dissolved oxygen concentration of the mixture of wastewater and stream;
(c) DO deficit of the mixture of wastewater and stream;
(d) ultimate BOD concentration of mixture of wastewater and stream;
(e) critical time to reach point of minimum DO concentration, and
(f) minimum DO concentration in stream. Also, comment on this result. [7.0]

Q.4 Answer the Following with not more than 500 words each. [3x2.0 = 6.0]

(a) Are worldwide water problems likely to increase or decrease in the coming decade? Explain your reasons pointwise.

(b) What is a Decision support system and how does it relate, or not relate, to model development or applications in the context of water resources planning?

(c) Why do flood damages continue to increase in spite of continually increasing expenditures on flood control?

-----WISH YOU ALL THE BEST-----