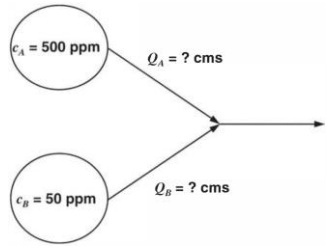
BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2022-2023
COMPREHENSIVE EXAMINATION (CLOSED BOOK)

COURSE NO.: CE G525 MAX. MARKS: 35 TIME: 3 Hours
COURSE TITLE: Water Resources Planning and Management DATE: 30/12/2022

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

Q.1(a) You require 4 m^3/sec of water with a salt content of 0.1 g/L for irrigation purposes. You have two reservoirs from which you can draw water. Reservoir A has a concentration of 500 ppm. whereas reservoir B has 50 ppm. What flow rate must be pumped from each reservoir to meet the objective? (2.0 M)



Q.1(b) Find the optimal levels of two goods purchased by a consumer with an objective function $u(x_1, x_2) = x_1^{1.5}x_2$ and a budget constraint $3x_1 + 4x_2 = 100$ using Lagrangian multiplier method. (3.0 M)

Q.2 Just downstream of the outfall from a pollution point source, the DO of a river is 6 mg/L, and the mix of river and wastes has a BOD of 20 mg/L. The saturation value of DO is 9 mg/L. The deoxygenation constant is k_d = 0.20/day. By assuming that the river speed is 0.25 m/s, and the average stream depth is 3 m, Answer the following:

(a) Estimate the reaeration coefficient using the O'Connor and Dobbins relationship $k_r = \frac{3.9 \times V^{1/2}}{H^{3/2}}$.
(b) Find the critical time downstream at which minimum DO occurs.
(c) Find the minimum DO downstream.
(d) If the outfall is the only source of BOD, what percent removal of BOD would be needed to assure a minimum DO of 5 mg/L? (5.0 M)

Q.3 An excess of 2 mg per L of oxygen develops in a river at the end of a 20-km section with a high concentration of attached plants. Determine the net photosynthesis rate of these plants in gram/m^2/day. The river has the following characteristics: Velocity of water (V) = 0.2 m/day, Depth of water (H) = 0.5 m, and coefficient of reaeration (k_r) = 2 day^{-1}. Assume that the river is at saturation when it starts to flow over the plants. (5.0 M)

Q.4(a) An aquifer pump test has been conducted in an unconfined aquifer of saturated thickness 15 m. The well was pumped at a rate of 100 L/s, and the drawdowns at 50 m and 100 m from the pumping well after 1 d of pumping were 0.412m and 0.251m, respectively. Estimate the transmissivity and hydraulic conductivity of the aquifer. Assume steady state. (3.0 M)

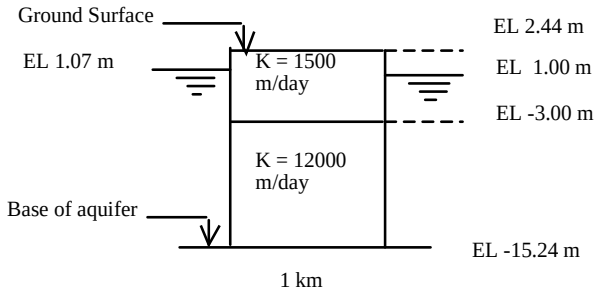
Q.4(b) Two houses are located adjacent to each other. House A has a septic system located 60 m up-gradient from the drinking water well for house B. The owner of house A disposed of a pesticide down the drain, causing the septic filled to become contaminated with this pesticide. The linear velocity of the water in the unconfined aquifer used for drinking water is 4.7×10^{-6} m.s^{-1}. Assuming that the pesticide does not degrade in the soil and that it has a retardation coefficient of 2.4, how many days will it take for the pesticide to reach the well of house B? Also describe the science behind capturing a contaminant plume with proper sketches. (2.0 M)

Q.5 River flows at a proposed reservoir site for a drought period of 15 months are given. The targeted demands for all releases found out from following table. If river flow and demands are in Mm^3, compute the storage required by sequent peak analysis.

Months	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
River flows	500	700	800	400	300	300	200	100	300	600	800	900	300	400	900
Demands	300	300	400	500	700	800	500	400	300	300	200	500	700	600	200

(5.0 M)

Q.6 A permeable aquifer consists of principally two layers: limestone formation with the hydraulic conductivity k= 1500 m/d and another formation with k = 12000 m/d. In one particular area, the limestone extends from ground surface at 2.44 m NGVD (National Geodetic Vertical Datum) to $-3.0\,\mathrm{m}$ NGVD and another layer formation extends from $-3.0\,\mathrm{m}$ NGVD to – 15.24 m NGVD. Calculate the shape of the phreatic surface and the flow rate between two fully penetrating canals 1 km apart, when the water elevations in the two canals are 1.07 m NGVD and 1.00 m NGVD.



(5.0 M)

Q.7 Write short notes on **four** of the following: (1.25 x 4 = 5.0 M)

(a) Use of DRASTIC model in Groundwater
(b) Use of EPANET in Water Distribution Network Analysis
(c) Use of CROPWAT for efficient irrigation water management
(d) Design of Water Conveyance System
(e) Groundwater contamination and plume size determination

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