BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2015-2016
COMPREHENSIVE EXAMINATION (OPEN BOOK/NOTES)

COURSE NO.: CE G525 TIME: 3 Hours
COURSE TITLE: Water Resources Planning and Management DATE: 02/12/2015
MAX. MARKS: 40%

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

Q.1 A newly graduated hydrologic engineer is to investigate why the community's groundwater supply varies so much during the year. It is extremely cold and there is much snow on ground when the engineer goes out to have a look at the groundwater wells in the area. The engineer finds that the water levels are all very low. In a well, not far from a small river, it is noticed that the water level is much lower than in the river.

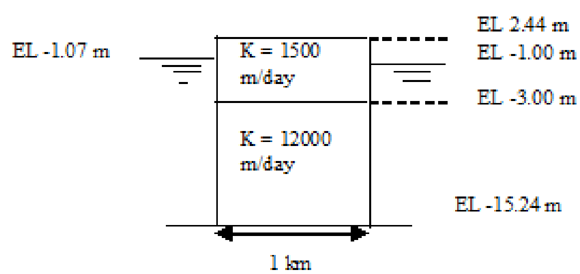
(a) How can it be explained that the groundwater level is lower than that of the river?

(b) If the engineer had been out during other seasons (spring, summer, autumn), what could the relationship between water levels in the river and groundwater have looked like? Try to draw figures.

(c) The engineer suspects that the storage term in the water balance plays a key role in the explanation. What is the storage term and how does it vary for different seasons?

(5.0 M)

Q.2 A permeable aquifer consists of principally two layers: limestone formation with the hydraulic conductivity k= 1500 m/day and another formation with k = 12000 m/day. In one particular area, the limestone extends from ground surface at 2.44 m NGVD (National Geodetic Vertical Datum) to -3.0 m NGVD and another layer formation extends from -3.0 m NGVD to – 15.24 m NGVD as shown in the figure. Calculate 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.

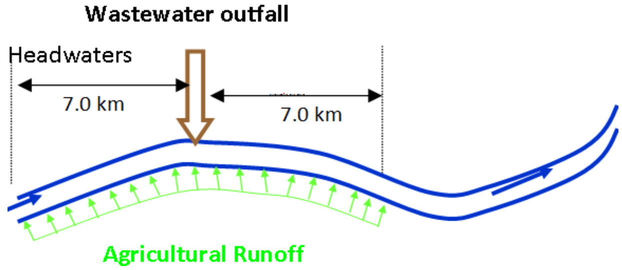


(10.0 M)

Q.3 A pump test was conducted in a confined aquifer where the initial piezometric surface was at elevation 14.385m, and well logs indicate that the thickness of the aquifer is 25 m. The well was pumped at 31.54 L/s, and after one day the piezometric levels at 50m and 100 m from the pumping well were measured as 13.585 m and 14.015m, respectively. Assuming steady state conditions, estimate the transmissivilty and hydraulic conductivity (permeability) of the aquifer. (5.0 M)

Q.4 A stream emerges from pristine headwaters and runs through an agricultural region before it reaches a city. The BOD of the headwaters is 4 mg/L, and the dissolved oxygen is 8.8 mg/L (saturation is 10.1 mg/L for 15°C). Starting at initial point, there is a significant non-point agricultural runoff of BOD amounting to 25 kg/km/day. At a point 7.0 km downstream, the stream is met by the WWTP outfall. Here a WW flow of 0.028 m^3/sec is discharged with a CBOD of 150 mg/L, an ammonia-N concentration of 24 mg-N/L and a DO of 6 mg/L. Immediately past this outfall is 7.0 km more distance of agricultural land which produces runoff BOD averages 9.5 kg/km/day. Calculate the dissolved oxygen concentration 7.0 kms downstream of the WWTP outfall at T=15°C. Assume the stream flow is constant at 1.15 m^3/sec from the headwaters to the end of the non-point agricultural runoff. You may also assume an SOD downstream of the WWTP outfall of 2.0 g/m^2/d. Please state any additional assumptions you made, and show all calculation. Also, take following additional information if required:

Stteam velocity U = 0.0450 m/sec	T = 15°C
DO_{sat} or C_s = 10.1 mg/L (at 15°C)	H = 1.22 m
BOD deoxygenation rate ($k_N = k_d$) = 0.8 day^{-1} (at 15°C)	θ for k_N and k_d, =1.047
CBOD settling rate (k_s) = 0.080 day^{-1} (at 15°C)	θ for reareation, =1.024



(10. M)

Q.5 The production function for a firm is $y = 5x_1x_2 + 2x_1^2$ where y is the level of production and x_1 and x_2 are two resource inputs. The costs of purchasing the resources are ₹5.00 and ₹8.00 per unit, respectively. Answer following questions:

(i) Develop an optimization model to determine the optimal resource purchases such that 5000 units of y will be produced. Write the mathematical equations of the objective function and all appropriate constraints for your model.

(ii) Write the Lagrangian for your optimization model:

(iii) What are the optimality conditions for your model using Classical Programming? Write the relevant mathematical equations. Also determine the optimal commodity purchases.

(iv) What is the interpretation of the Lagrange multiplier in this problem?

(4.0 M)

Q.6 Answer any **two** questions of the following: (3x2.0 = 6.0 M)

(a) Describe some water resource systems consisting of various interdependent components. What are the inputs to the systems and what are their outputs? How did you decide what to include in the system and what not to include? How did you decide on the level of spatial and temporal detail to be included?

(b) Many water resource systems planning problems involve considerations that are very difficult if not impossible to quantify, and hence they cannot easily be incorporated into any mathematical model for defining and evaluating various alternative solutions. Briefly discuss what value these admittedly incomplete quantitative models may have in the planning process when non-quantifiable aspects are also important. Can you identify some planning problems that have such intangible objectives?

(c) What do you understand by point and non-point sources of pollution? How would you incorporate non-point source modeling in a river a basin planning? Explain briefly.

----Wish You All the Best----