BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2016-2017
COMPREHENSIVE EXAMINATION (OPEN BOOK)

COURSE NO.: CE G525 TIME: 3 hours
COURSE TITLE: Water Resources Planning and Management DATE: 09/12/2016
MAX. MARKS: 35%

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

Q1. The combination of three technologies is used to remove a certain pollutant from wastewater. The three technologies remove 1, 2, and 3 g/m^3 of the pollutants, respectively. The third technology variant seems to be the best, but it cannot be applied to more than 50% of the wastewater being treated. The costs of applying the technology variants are ₹5, ₹3, and ₹2 per cubic meter. If 1000 m^3 must be treated in a day, and at least 1.5 g/m^3 of pollutant has to be removed, then clearly answer the following:
(a) Formulate the above problem as linear programming problem to determine the amount of wastewater (in m^3) for which technologies 1, 2 and 3 are used.
(b) Solve the above linear programming problem using graphical method? Explain the complete methodology stepwise using the graph paper. **[2 + 3]**

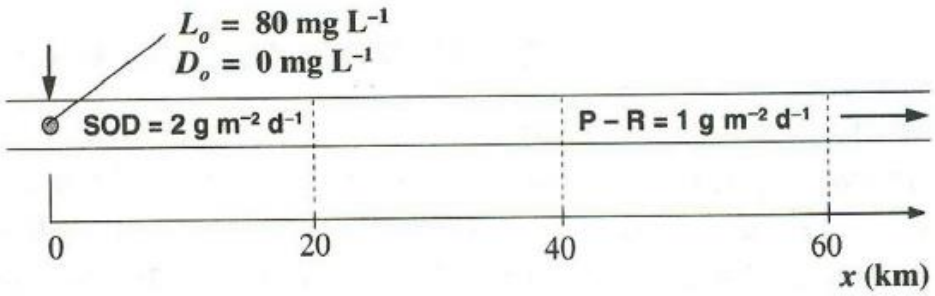
Q2. A water project is proposed to supply water for municipal and irrigation uses. Municipal demand is given by P + 2Y = 10, and irrigation demand is given by 2P + Y = 20, where P is the price and Y is the demand.
i. Determine the aggregate demand curve using graph paper.
ii. Assuming the total cost revenue is given by C = (1/4) Y2 + Y, determine the optimal level of Y.
iii. Determine the share of municipal and irrigation supplies at optimal level of Y. **[2 + 2 + 1]**

Q3. Two alternative plans are considered for a section of an aqueduct. Plan A uses a tunnel, and Plan B uses a lined canal and steel flume. Both plans yield the same revenues over the life of the project. Compare the equivalent annual costs of the two plans and conclude your results if interest rate is 6 % per year and the study period of the project is 100 years. **[3]**

	Plan A	Plan B		
Parameters	Tunnel	Canal	Canal lining	Flume
Life	100 yr	200 yr	20 yr	50 yr
Initial Cost (₹)	450,000	120,000	50,000	90,000
Annual O & M cost (₹)	4000	-	10,500	-

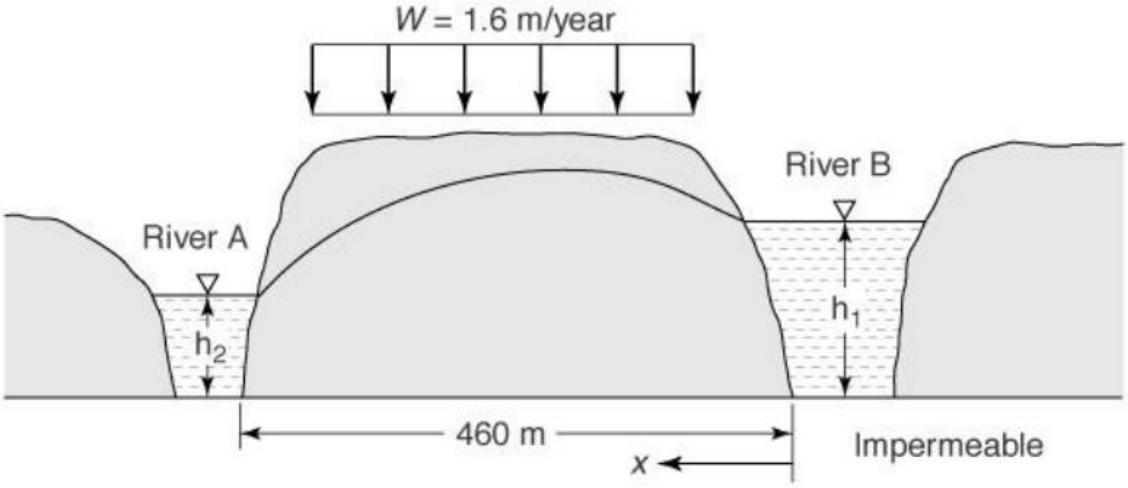
Q4. A river is subjected to a point source of BOD and diffuse sources of oxygen deficit, as shown in Fig. Compute the BOD and oxygen concentration at 20 km, 40 km and 60 km downstream from the origin points as shown in the Figure Q.2. Assume kd = rate of BOD removal (dissolved form only) coefficient; k_r = rate of overall BOD removal (both settling and dissolved form) coefficient; k_a = rate of aeration coefficient; o_s = saturated dissolved oxygen concentration; H = depth of river

water; U = stream velocity; L_o = initial BOD concentration; D_o = initial DO deficit. You may assume velocity to be 0.1 m/s. **[6]**



U (mps)	0.1	0.15	0.1
H (m)	0.8	1	1
k_r (d^{-1})	0.2	0.1	0.1
k_d (d^{-1})	0.1	0.1	0.1
k_a (d^{-1})	1	1.2	1.2
o_s (mg L^{-1})	10	9	8

Q5. An unconfined aquifer of clean sand and gravel is located between two fully penetrating rivers (see figure) and has a hydraulic conductivity of K = 10^{-2} cm/sec. The aquifer is subjected to a unifrom recharge of 1.6 m/year. The water surface elevations in rivers A and B are 8.5 m and 10 m respectively, above the bottom. Estimate the a) maximum elevation of the water table and the location of groundwater divide, b) the travel times from the groundwater divide to both rivers (n_e = 0.35) and c) the daily discahrge per kilometer from the aquifer into both rivers. **[5.5]**



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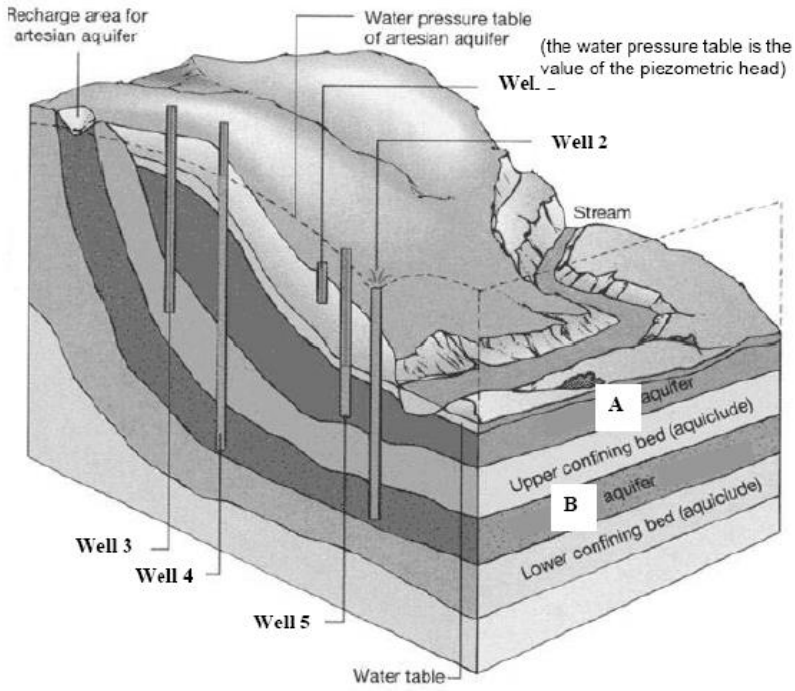
Q6. Consider the drawing below with wells 1-5 and aquifers A and B. The dashed line for the water pressure table of artesian aquifer is the piezometric head of aquifer B. The piezometric head is the same thing as the hydraulic head, which we have denoted as H. **[3]**

(a) Which aquifer(s) is/are unconfined aquifers and why?
(b) For the wells 2, 4, and 5, list them in order of the energy needed to bring a given amount of water to the ground surface. List from the least amount of energy to the greatest. Assume that the porosity and hydraulic conductivity of aquifers A and B are the same.



Q7. A well of 0.5 m diameters penetrates 33 m below the static water table. After a long period of pumping at a rate of 80 m^3/hr, the drawdown in wells 18 m and 45 m from the pumped well were found to be 1.8 m and 1.1 m respectively. a) What is the transmissivity of the aquifer? b) What is the appraoximate drawdown in the pumped well? c) Determine the radius of influence of the pumping well. **[1 x 3 = 3]**

Q8. Answer any three questions of the following: **[1.5 x 3 = 4.5]**

a) Identify some of the major water resource management issues in BITS Pilani. What management alternatives might effectively reduce some of the problems or provide additional economic, environmental, or social benefits.

b) Differentiate (at least 3 points) WMS and WASP softwares with respect to their application in water resouces management problems.

c) Industries near Ganges in Kanpur stretch are extracting as much as 1200 MLD from the Ganges. Water engineers come up with the solution of constructing some reservoirs for storing rainwater which can serve the water demands of the inddustries thereby reducing dependence on Ganges. Discuss three advantages and disadvantages of this appraoch.

d) Mention various sources of groundwater pollution. As a water engineer what all water quality paremeters would you take into account while studying groundwater pollution. Discuss highlighting the harmful effects of these parameters.

**********ALL THE BEST**********