KUMARAGURU college of technology
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Register Number:……..…

M.E DEGREE EXAMINATIONS: APRIL/MAY 2024

(Regulation 2018)

Second Semester

ENVIRONMENTAL ENGINEERING

P18EET2002**:** Water Quality Modelling

COURSE OUTCOMES

CO1: Develop conceptual schematics required for modeling.

CO2: Assess the surface water quality modeling performance.

CO3: Design the transport phenomena for different reactor models.

CO4: Predict groundwater flow and contaminant transport.

CO5: Develop Numerical models to simulate the water quality.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Assertion (A): Mathematical modeling enables researchers to minimize the financial ex penditure associated with technological innovation. CO1 [K_1]
   Reason (R): The impact of parameter modifications can be effectively analyzed using a mathematical model, making it a potential alternative to laboratory experiments.
   a) Both A & R are individually correct, and R is the exact reason for A
   b) Both A & R are individually correct, and R is the not exact reason for A
   c) A is correct and R is invalid
   d) A is invalid and R is correct
2. The optimal discretization method for representing the irregular spread area of surface water will be CO5 [K_1]
   a) Finite point mechanism
   b) Finite Element Method
   c) Finite Difference method
   d) Control volume approach
3. If a model attempts to replicate the current state of a field in a modeling method, it is referred to as CO1 [K_1]
   a Prediction model
   b Simulation model
   c Computational model
   d Optimization model

4. Matching type item with multiple choice code CO4 [K_1]

List I	List II
A. Unsaturated aquifer	i. Darcy equation
B. Saturated aquifer	ii. gradient in water level
C. Flow velocity	iii. Richards equation
D. thickness of the flow media	iv. Transmissivity

	A	B	C	D
a)	i	ii	iii	iv
b)	iii	i	iv	ii
c)	iii	i	ii	iv
d)	i	iii	iv	ii

5. The Streeter Phelps equation is employed to model the dissolved oxygen (DO) levels in a river with a flow velocity of 1.5 m/s. If the temperature rises by 1 degree Celsius Statement (A): The river's maximum Do holding capacity is increasing. Reason (R): The surface air temperature has an impact on the oxygen saturation. CO2 [K_2]

a) Both A & R are individually correct, and R is the exact reason for A
b) Both A & R are individually correct, and R is the not exact reason for A
c) A is correct and R is invalid
d) A is invalid and R is correct

6. Within a river-lake system, the river supplies the lake with water that has a high Biochemical Oxygen Dem and (BoD) due to the discharge of wastewater from factories situated along the river's path. CO2 [K_2]

You have been requested by the local government body to create a model that accuratel y assesses the quality of lake water.

How can you demonstrate the reliability of your developed model's predictions in the g iven scenario?

a) Calibration
b) Parameter estimation
c) Performance Index
d) Number of parameters

7. When dealing with PFR (Plug Flow Reactor), during the development of the design or performance equation, a narrow section within the reactor is responsible for this phenomenon. CO3 [K_2]

a) The change in concentration along the length of the reactor, and mass balance cannot be applied if concentration is changing within the domain of study or control volume

b) The change in concentration along the width of the reactor is constant, that is reason mass balance is applied to small strip

c) PFR length may infinite, that is the reason mass balance is applied to a small strip and integrated to the length of the reactor

d) That is a base assumption made in PFR design

8. The painting industry is releasing its wastewater into the adjacent water body. The analysis of the water sample reveals the presence of measurable amounts of heavy metals in the effluent, which are harmful to the human food chain. In the given scenario, it is necessary to determine if the governing equation will be taken into consideration. CO2 [K_2]

a) Advection Phenomenon

b) Advection & Diffusion

c) Diffusion / Dispersion

d) Advection and Diffusion as pseudo coupled phenomenon

9. Consider a scenario in which the river is flowing at a height of 0.5 meters and a velocity of 0.8 meters per second. In this scenario, it is necessary to model the interaction between atmospheric air and river movement. If this is the case, the impact of this interaction will be seen in CO2 [K_2]

a) Oxygen saturation

b) Microbial growth

c) Critical length of dilution

d) Mixing length

10. In a river-lake system, the river supplies the lake with water that has a high Biochemical Oxygen Demand (BoD) due to the discharge of wastewater from factories situated along the river. You have been requested by the local government body to create a model that accurately assesses the quality of lake water. To construct a modeling technique, sequence the below approach CO2 [K_2]

1. Conduct water sampling in the lake.
2. Establish the governing equation.
3. Comprehend the actual conditions of the river-lake system (boundary conditions). Formulating suitable hypotheses

a) 1-3-2-4

b) 1-4-2-3

c) 1-3-4-2

d) 1-2-3-4

PART B (10 x 2 = 20 Marks)

11.	The research team have a firm grasp on conducting experimental studies, and it is your responsibility to emphasize the significance of mathematical modeling. What evidence do you have to support or underline the necessity of mathematical modeling?	CO1	[K_2]
12.	Is calibration necessary for a formed mathematical relationship? If so, please provide justification for your viewpoint.	CO1	[K_2]
13.	You are required to create a water quality model for the Cauvery River that specifically measures the levels of dissolved oxygen. Which variables will you consider as independent and dependent variables?	CO2	[K_2]
14.	You are required to simulate the flow of a river with a depth of around 0.05 meters and a width of 0.25 kilometers. Will you incorporate atmospheric interaction into your modeling procedure? If so, please provide a rationale for your decision.	CO2	[K_2]
15.	Turbulence in the river flow transports particles or contaminants in the same direction a s the flow. Whether you refer to the transport phenomenon as advection or diffusion.	CO3	[K_2]
16.	Turbulence generated by air temperature carries particles or contaminants throughout the river's depth. Whether you refer to the transport phenomenon as advection or diffusion.	CO3	[K_2]
17.	When freshwater from inland flows towards the coastal boundary, can it be considered as seawater intrusion? Please provide a justification for your perspective.	CO4	[K_2]
18.	Justify your viewpoint on whether the depth of the aquifer from the top soil impacts the yield that can be extracted.	CO4	[K_2]
19.	The outputs from a numerical model display values of equal magnitude but opposite signs. Provide an assessment of the stability of the model or system.	CO5	[K_2]
20.	When the topsoil is not completely saturated. Can the Darcy equation be used to calculate the flow velocity?	CO5	[K_2]

PART C (10 x 5 = 50 Marks)

21.	Outline the procedural processes involved in model development.	CO1	[K_2]
22.	Let us consider a linear correlation between the temperature of the atmosphere and the concentration of dissolved oxygen in the river. Explain the procedure for determining the value of the parameter in the linear model.	CO1	[K_3]
23.	Create a theoretical model for river water quality that is capable of simulating the levels of dissolved oxygen in the river. Identify the underlying assumptions, conditions,	CO2	[K_3]

governing equation, and other relevant elements necessary for simulating the desired variable.

24.	Explain the impact of oxygen saturation level on the concentration of dissolved oxygen in a simulated river.	CO2	[K_2]
25.	Describe the plug flow reactor.	CO3	[K_2]
26.	Classify Plug flow reactor and Mixed flow reactor.	CO3	[K_2]
27.	If you require the simulation of groundwater levels using limited or infrequent monitoring data. Please explain your chosen strategy and provide reasons to support your choice.	CO4	[K_3]
28.	If the region of interest is located 30 meters below the top soil, it is necessary to take into account the recharging of the top soil while calculating groundwater levels. Provide a rational basis for your perspective.	CO4	[K_3]
29.	Consider the continuity equation for a two-dimensional flow and attempt to discretize it using i) a central difference scheme, and ii) a backward scheme.	CO5	[K_2]
30.	Discuss on the stability condition with reference to explicit schemes.	CO5	[K_2]

Answer any TWO Questions
PART D (2 x 10 = 20 Marks)

31.	Agriculture is often considered the primary vehicle behind the expansion of India's gross domestic product. However, the COVID-19 epidemic-induced national closure has led to a decline in agricultural yield for a variety of unacknowledged reasons. In this scenario, the government of the state of Tamil Nadu has made the decision to increase agricultural productivity by increasing the proportion of land that is suitable for agricultural use. This system is responsible for rerouting the water that comes from the Bhavani river into the Lower Bhavani canal, also known as the LBC. The Lower Bhavani Canal, which has been rerouted, eventually feeds into the Noyyal River, which is located downstream of the Orthapalayam dam. In contrast, the River Noyyal is notorious for having water quality that is below acceptable standards. The phenomenon of dilution has the ability to bring about an improvement in the water quality of the river Noyyal at the location where LBC drains into the river Noyyal. This improvement could be brought about by the dilution process. The purpose of this project is to develop a modeling framework that is capable of properly reproducing the temporal changes in the water quality of the Noyyal River.	CO1 & CO2	[K_5]

32. With reference to the scenario that is described in Question 31, what are some of the parameters that have an impact on the equation or model that represents the dissolved oxygen simulation? CO2 [K_3]

33. India is famous for its abundant cultural heritage and heterogeneous population. Similarly, based on monitoring data from IMD, it is clear that rainfall shows substantial variation across the entire country. Agriculture has a substantial impact on India's Gross Domestic Product (GDP). Due to the circumstances of rising agricultural demand and erratic rainfall patterns, farmers actively search for various water sources to guarantee their existence. A water source that is acknowledged by the global agricultural community is domestic wastewater, whether treated or untreated, which is renowned for its elevated nutritional content. Africa and India are leading the way in harnessing this water resource for agricultural use. WHO approaches you to develop a conceptual framework for understanding the movement of a toxic material in the interaction between soil, water, and plants. Share your approach to developing a simulation model that precisely mimics the passage of hazardous substances into the groundwater system. CO5 [K_5]

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