KUMARAGURU
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M.E DEGREE EXAMINATIONS: DEC 2022

(Regulation 2018)

Second Semester

ENVIRONMENTAL ENGINEERING

P18EET2002: Water Quality Modeling

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 helps the researcher to reduce the cost invested   CO1   [K$_1$]
     on a technological innovation

     Reason (R): Influence of Parameter variations may be well studied through a

     mathematical model and it can be a replacement of lab studies

     a)   Both A & R are individually correct,   b)   Both A & R are individually correct,
          and R is the exact reason for A   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.   To model the irregular surface water spread area, the most suitable discretization will   CO5   [K$_1$]
     be

     a)   Finite point mechanism   b)   Finite Element Method

     c)   Finite Difference method   d)   Control volume approach

3.   In a modeling approach, if a model tries to mimic the existing field reality, then it is   CO1   [K$_1$]
     termed to be

     a   Prediction model   b   Simulation model

     c   Computational model   d   Optimization model

4. Matching type item with multiple choice code   CO4   [K₁]

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. Assertion(A): The maximum minimum DO level for aquatic organism survival is   CO2   [K₂]
   4 ppm

   Reason (R): Oxygen saturation is influenced by the surface air temperature

   a) Both A & R are individually correct,   b) Both A & R are individually correct,
   and R is the exact reason for A   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. In a river-lake system, the river feeds the lake with a water quality that has high BoD   CO2   [K₂]
   because of the effluent that is being discharged by the industries that are located along
   the river course. The local government authority has approached you to develop a lake
   water quality model. In the above case, how you showcase the dependability of your
   developed model prediction based on

   a) Calibration   b) Parameter estimation

   c) Performance Index   d) Number of parameters

7. In case of PFR, in the process of developing the design or performance equation, a   CO3   [K₂]
   small strip within the reactor this is due to

   a) The change in concentration along the   b) The change in concentration along the
   length of the reactor, and mass balance   width of the reactor is constant, that is
   cannot be applied if concentration is   reason mass balance is applied to small
   changing within the domain of study or   strip
   control volume

   c) PFR length may infinite, that is the   d) That is a base assumption made in PFR
   reason mass balance is applied to a   design
   small strip and integrated to the length
   of the reactor

8. An electroplating industry is discharging its effluent in the nearby water body. From the water sample analysis, it is understood that the effluent has quantifiable heavy metals that are toxic to the human food chain. In the above case, whether the governing equation will consider   CO2   [K$_2$]

   a) Advection Phenomenon

   b) Advection & Diffusion

   c) Diffusion / Dispersion

   d) Advection and Diffusion as pseudo coupled phenomenon

9. Assume a case, where the river flows at a stage height of 0.25 m with a flow velocity of 0.6 m/s. In such a case, whether interaction between atmospheric air and river flow has to be modelled. If so the influence of this interaction will be reflected 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 feeds the lake with a water quality that has high BoD   CO2   [K$_2$]
    because of the effluent that is being discharged by the industries that are located along the river course. The local government authority has approached you to develop a lake water quality model. In the above case, sequence the steps listed below, to build up a modeling approach

    1. Do water sampling in the lake
    2. Set up the governing equation
    3. Understand the field reality of the river-lake system (boundary conditions)

    Creating appropriate assumptions

    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. Emphasize the need of mathematical modelling   CO1   [K$_2$]

12. Whether calibration is required for developed mathematical relation, if so justify your view point.   CO1   [K$_2$]

13. For river noyyal you are supposed to develop a water quality model capturing Dissolved oxygen. What will be your independent variables and dependent variables?   CO2   [K$_2$]

14. You are supposed to model a river flow (the flow depth is almost 0.1 m), which has a width of 0.5 km. Whether you will consider atmosphere interaction in your modelling procedure, if so justify your view point.   CO2   [K$_2$]

15. A particle or a contaminant is carried by the turbulence in the river flow along the direction of flow. Whether you term this transport phenomenon as Advection or Diffusion?   CO3   [K$_2$]

16.	A particle or a contaminant is carried along the depth of the river due to turbulence created by the atmospheric temperature. Whether you term is transport phenomenon as Advection or diffusion?	CO3	[K$_2$]
17.	When fresh water from inland moves towards the coastal boundary, whether it can be termed as sea water intrusion, justify your view point.	CO4	[K$_2$]
18.	Whether the depth of the aquifer from the top soil determines the yield that can be drawn from the aquifer, justify your view point.	CO4	[K$_2$]
19.	The results from a numerical model visualizes a positive and negative values of same magnitude, comment on the stability of the model/ scheme.	CO5	[K$_2$]
20.	The top soil is not fully saturated, comment on the applicability of Darcy's equation for computation of the flow velocity.	CO5	[K$_2$]

PART C (10 x 5 = 50 Marks)

21.	Illustrate the steps / sequence that is associated with model development.	CO1	[K$_2$]
22.	Assume a linear relationship that exists between atmospheric temperature and dissolved oxygen concentration in the river. Illustrate the process of estimating the parameter that exists in the linear model.	CO1	[K$_3$]
23.	Develop a conceptual river water quality model that can simulate the dissolved oxygen in the river. Highlight the assumptions, conditions, governing equation, and other associated terms that required to simulate the intended variable.	CO2	[K$_3$]
24.	Illustrate the influence of oxygen saturation level in the simulated river dissolved oxygen concentration.	CO2	[K$_2$]
25.	Differentiate batch reactor and continuous flow stirred tank reactor	CO3	[K$_2$]
26.	Explain the various reasons for saline water intrusion in coastal zones	CO3	[K$_2$]
27.	In case you need to simulate the groundwater, levels using sparse / few days of monitoring. What will be your preferred method, justify your stand?	CO4	[K$_3$]
28.	In the computation of groundwater levels, whether top soil recharge need to be considered if your area of interest is 50 m below the top soil. Justify your viewpoint.	CO4	[K$_3$]
29.	Assume the continuity equation for a 2D flow, and try to discretize in i) central difference scheme, and ii) Crank-Nicolson scheme	CO5	[K$_2$]
30.	Discuss the stability condition with reference to explicit schemes.	CO5	[K$_2$]

31. Agriculture is believed to be the backbone of Indian GDP growth, in this COVID 19 national shutdown period the yield has reduced due to many unquoted reasons. In a such a situation, the Tamilnadu state government takes a decision to increase the agricultural yield by increasing the percentage of cultivable land. Under this scheme, the water from the Bhavani river is diverted into the Lower Bhavani canal (LBC). The diverted LBC drains into the Noyyal river below orthapalayam dam. On the other hand, River Noyyal is known for its poor water quality. At draining point of LBC into river Noyyal, there is a possibility improvement in river Noyyal water quality due to dilution phenomenon. Your target is to develop a modeling framework to simulate the river Noyyal water quality with respect to time. CO1 [K$_5$]

32. Explain the various parameters that influence the Dissolved Oxygen Simulation Equation / Model CO2 [K$_3$]

33. Share your views on developing a simulation model that mimics the relationship between soil-water and plant. CO5 [K$_5$]

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