KATHMANDU UNIVERSITY
End Semester Examination
22- January 2024

Marks Scored:

Level : B.Sc./B.Tech.
Year : IV

Course : ESEE 403
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date :

SECTION "A"
[20Q. × 1 = 20 marks]

Choose and encircle the most appropriate answers from the given choices

1. An air pollution dispersion model is used for nitrogen oxides pollution dispersion modeling. It uses the Gaussian plume transport modeling approach. What type of output is obtained from this model?
   a. Quantitative and stochastic
   b. Quantitative and deterministic
   c. Qualitative and deterministic
   d. Qualitative and stochastic

2. A city is 6 km wide and 25 km long. The mixing height is 1500 m and the average wind speed is 4 m/s. If the upwind concentration of a pollutant is 9 $\mu g/m^3$, and the emission rate per unit area is 8×10^{-6} $g/s \cdot m^2$, what is the concentration of the pollutant over the city in $\mu g/m^3$?
   a. 155 b. 42 c. 2400 d. 5.4

3. What can you use to simulate the water quality of Punyamata river quality?
   a. CSTR model
   b. Linear reservoir model
   c. Streeter-Phelps model
   d. Multimedia model

4. What is the spatial scale of a typhoon?
   a. urban scale b. microscale c. synoptic scale d. mesoscale

5. What is the concentration profile for reactions of order one?
   a. $C = C_0/(1 + C_0 kt)$
   b. $C = C_0 - k$
   c. $C = C_0 \exp(-kt)$
   d. $C = C_0 - kt$

6. To address the question 'Why does ozone affect the paints in a house?', which of the following mathematical approaches would most likely be used?
   a. Mechanistic b. Statistical c. Physical d. Lumped

7. Why do you introduce a virtual source at $z = -h$ in Puff models?
   a. to include surface reflection
   b. to include surface emissions
   c. to include high-altitude mass
   d. to include underground emissions

8. What do you use to solve models that are both distributed and dynamic in nature?
   a. ODEs
   b. algebraic equations
   c. linear equations
   d. PDEs

9. Where do you apply kinematic wave model?
   a. saturated flow b. unsaturated flow c. overland flow d. groundwater

10. Which type of model is generally used in modeling the Nepalese watersheds?
a. lumped b. probabilistic c. semi-distributed d. physical

11. If you want to simulate carbon dioxide in the atmosphere, which type of model would you generally choose?
a. urban b. local c. global d. regional

12. In environmental transport and transformation, what is the most common order of the processes?
a. zeroth b. first c. second d. third

13. In computer programs, if you need to do numerical modeling, what do you commonly use?
a. analytical equations b. continuous equations
c. simultaneous equations d. finite difference equations

14. What does $v(dC/dx)$ denote in environmental transport phenomena?
a. advection b. diffusion c. deposition d. decay

15. If you are simulating river quality, what can be used as a substitute for river pollutants?
a. DO b. BOD c. COD d/ SS

16. What type of model is generally used in hydrological models for percolation/infiltration?
a. 0D model b. 1D model c. 2D model d. 3D model

17. A person uses Gaussian plume model to check if a brick kiln is affecting the neighborhood. What type of model is it?
a. stochastic b. deterministic c. empirical d. lumped

18. Which reactor model has no axial mixing but only radial mixing?
a. CSTR b. PFR c. Batch d. Streeter-Phelps

19. What can be used to quantify the sensitivity of a model?
a. mean bias b. sample correlation coefficient
c. coefficient of determination d. importance index

20. What is the fugacity related to?
a. ambient temperature b. partial pressure
c. humidity d. rate of heat transfer

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SECTION "B"

Attempt *ALL* questions. The data or information not given in the questions should be assumed properly.

1. a. Explain various methods of classifying an environmental model. [4]
   b. How do you evaluate a model using sensitivity analysis? [2]

2. The advective-diffusive transport of a pollutant in a river is undergoing a first-order decay reaction.
   a. Write a general transport model equation for this system. [2]
   b. Then develop the finite difference formulation to solve this model numerically. [4]

3. In a waste treatment system, two CSTRs are installed in series, whose hydraulic residence times are 5 days and 10 days respectively. What is the percentage reduction of a pollutant that can be obtained by this system if the rate constants for the decaying reactions in the two reactors are 1.6/day and 0.6/day respectively? [6]

4. Using Green-Ampt model, calculate cumulative infiltration after 0.3 hr from the beginning of infiltration for a silty clay soil with porosity, $\varepsilon = 0.48$, suction head, $\Psi = 31.3$ cm, and $K = 0.04$ cm/hr. Assume the initial effective saturation is 41 percent. The effective porosity for the silty clay soil is 0.41. [6]

5. Xylene is emitted by an industrial factory at the rate of 70 g/s from an effective height of 55 m. The ambient wind blowing on that day is 3.5 m/s. A group of people are standing 4 km downwind of the factory, where the horizontal and vertical dispersion coefficients are estimated from a reference as 444 m and 222 m respectively. Find the concentration of xylene when the wind reaches those people. [6]

6. How do you model topo-hydrological distribution? What inputs are needed to run it? [3+2=5]

7. Explain why Streeter-Phelps model is classified as a plug flow reactor with a clear diagram showing the dissolved oxygen sag curve. [5]

8. Explain fugacity and its usefulness in multimedia modeling of the environment. [5]

[4 × 2.5=10]

9. Describe briefly:
   a. Box model for air quality assessment of Kathmandu Valley
   b. Parameterizations used in atmospheric and climate models
   c. Monod model for methane emission
   d. Use of Darcy's law in environmental modeling