

KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

Marks Scored:

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

Course : ENVS 404
Semester: I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date

FEB 25 2019

SECTION "A"

[20 Q. × 1 =20 marks]

Select the correct answer from the given choices. Attempt all the questions.

1. When the variables (in a static system) or their changes (in a dynamic system) are well defined with certainty, the relationships between the variables are fixed, and the outcomes are unique, then the model of that system is said to be:
(a) continuous (b) distributed
(c) deterministic (d) stochastic
2. Which step in the development of a model uses previously observed data from the real system as a training set?
(a) system definition (b) coding computer programs
(c) mathematical formulation (d) calibrating the parameters
3. In a typical environmental modeling research, which type of modeling will use large number of arrays or grids?
(a) static (b) analytical (c) lumped (d) distributed
4. Which of the following metrics is suitable for quantifying model uncertainties?
(a) importance index (b) sample correlation coefficient
(c) lack of fit (d) root mean square error
5. Which numerical method is best applicable to solve an ODE for environmental modeling?
(a) Runge-Kutta (b) Integrating Factor
(c) finite difference (d) finite element
6. What are the two inputs required to run TOPMODEL?
(a) precipitation and temperature (b) temperature and potential evapotranspiration
(c) temperature and humidity (d) precipitation and potential evapotranspiration
7. Which of the following GIS commands will produce drainage of a basin?
(a) r.in.gdal (b) r.water.outlet (c) r.watershed (d) r.drain
8. Which of the following model is the most suitable for climate change modeling?
(a) Gaussian dispersion (b) GCM
(c) EBM (d) box
9. Which of the following is the terrain-following vertical coordinate system?
(a) isentropic (b) isobaric (c) rectangular (d) sigma
10. A rectangular channel has bed slope of 1 percent and Manning roughness of 0.035. What is the friction slope if kinematic wave model is valid?
(a) 0.00035 (b) 0.01 (c) 0.29 (d) 1.0
11. In an unsaturated porous medium, the part of the total energy possessed by the fluid due to soil but not available in saturated flow is referred to as the:
(a) total head (b) gravity head (c) suction head (d) friction head

12. If the octanol-water partition coefficient is very large, the substance is:
 (a) more hydrophilic (b) more lipophilic (c) amphibolic (d) inert
13. Which one of the following best describes the box model of air pollution?
 (a) Gaussian dispersion (b) Reservoir
 (c) PFR (d) CSTR
14. A toxic pollutant was released into an aquifer. Downstream from the release point, a drinking water well receive water from this aquifer. Animals drink the water and the concentration of the pollutant builds up in animals. If the amount transferred to the liver of animal undergoes the metabolic process, which model will you use for this process?
 (a) Michaelis-Menten (b) Richards
 (c) Fugacity (d) Streeter Phelps
15. A factory emits 20 g/s of SO_2 at height H . The wind speed is 3 m/s. At a distance of 1 km downwind, the values of σ_y and σ_z are 30 m and 20 m, respectively. What is the SO_2 concentration at the centerline of the plume in $\mu\text{g}/\text{m}^3$?
 (a) 0.001 (b) 1768 (c) 3536 (d) 15915
16. What will make oxygen concentration converge to the saturation limit?
 (a) reaeration (b) inflow rate (c) degradation (d) bacteria
17. If temperature is 300 K, Henry's constant is $10 \text{ Pa}\cdot\text{cu m}^3/\text{mol}$, and universal gas constant is $8.314 \text{ m}^3\cdot\text{Pa}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$, what is the fugacity capacity of water in $\text{mol}/\text{Pa}\cdot\text{m}^3$?
 (a) 0.0003 (b) 0.0004 (c) 0.1 (d) 30
18. The mass removal rate by a reaction in environmental processes can be found by:
 (a) dC/dt (b) $V(dC/dt)$ (c) $k(dC/dt)$ (d) $kV(dC/dt)$
19. If a pollutant is 100 mg/L in a stream input to a series of three CSTRs, $k=1.5/\text{day}$, residence time is 5 days, what is the output concentration of the pollutant from the last CSTR in mg/L?
 (a) 0.16 (b) 11.76 (c) 100 (d) 0.002
20. Which of the following process can be well represented by a PFR model?
 (a) river flow (b) room pollution (c) stack emission (d) lake pollution

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Semester: I
F. M. : 55

SECTION "B"

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

1. Consider the discharge of a pollutant into a lake. Briefly explain the specific conditions to differentiate the following types of models to simulate the pollution: [4 × 2=8]
 - a) Deterministic Vs. Probabilistic
 - b) Continuous Vs. Discrete
 - c) Static Vs. Dynamic
 - d) Distributed Vs. Lumped
- 2) Provide a specific example of the application of each of the following Python functions to create environmental data: [6 × 1=6]
 - a) array b) arange c) linspace d) zeros e) range f) meshgrid
- 3) The modified form of the kinematic wave model is given as $\frac{\partial Q}{\partial x} + \alpha\beta Q^{\beta-1} \frac{\partial Q}{\partial t} = q$ with the usual meanings of the variables.
 - a) How do you get a numerical solution of this model using finite difference? [4]
 - b) What is the use of kinematic wave model in hydrological modeling? [3]
- 4) What are the main components of climate models? Why parameterizations are used in atmospheric and climate models? [4+2]
- 5) Use Green-Ampt method to compute infiltration rate and cumulative infiltration after 1 hour from the beginning of infiltration for a silty clay soil with porosity, $\epsilon = 0.479$; suction head, $\Psi = 29.22$ cm; $K = 0.05$ cm/hr. Assume the initial effective saturation is 30 percent and it have continuous ponding. The effective porosity for the silty clay soil is 0.423. [5+2]
$$F(t) = Kt + \psi\Delta\theta \ln \left(1 + \frac{F(t)}{\psi\Delta\theta} \right)$$
- 6) A tunnel whose estimated time of completion is 2022 has the following dimensions: $L = 305$ m, $W = 21$ m, $H = 8$ m. Wind parallel to the tunnel is blowing into the tunnel with a speed of 3.6 m/s. It is estimated that 3000 vehicles per hour, with a 5% heavy duty vehicle (hdv) mix, running at an average speed of 64.4 km/h, will travel through the tunnel during the highest vehicle rate period. It is given that 13.67 grams of CO is emitted per km @ 5% hdv per vehicle. Estimate the carbon monoxide (CO) concentration within the tunnel during maximum use by using a box model. [7]
- 7) An SO₂ monitor is mounted on a meteorological tower 2000 m downwind of a stack having height of 100.7 m and plume rise of 186.3 m. The stack emits 232 g/s of SO₂. The monitor is at the level of 200 m above ground. For these conditions, the dispersion parameters are $\sigma_y = 146$ m and $\sigma_z = 60$ m. For a gray day with the measured wind speed at 5.6 m/s and an air temperature of 18°C, estimate the concentration measured by the monitor using the Gaussian Dispersion Model that also considers a virtual image source. [7]
- 8) A first-order removal process is to be evaluated for various types of reactor configurations and we should have removal efficiency of 90% and rate constant k is given as 0.1. The removal efficiency is given as $1 - C_{out}/C_{in}$.
 - a) Find the hydraulic retention time for a Completely Mixed Flow Reactor (CMFR). [3]
 - b) Find the hydraulic retention time for a Plug Flow Reactor (PFR). [3]
 - c) What metrics can you use for sensitivity analysis of the model? [1]

