KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2018

Marks Scored:

Level : B. Tech.
Year : IV

Course : ENVS 404
Semester: I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date : MAR 12 2018

SECTION "A"
[20 Q × 1 = 20 marks]

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

1. An environmental model is classified according to its application as:
   (a) qualitative or quantitative (b) functional or mechanistic
   (c) deterministic or stochastic (d) descriptive or predictive

2. If you want to understand how the global warming affects the rainfall in coming decades, which type of model will you use?
   (a) static, descriptive and mechanistic (b) static, predictive and functional
   (c) dynamic, predictive and mechanistic (d) dynamic, descriptive and functional

3. A maximum hourly load was calculated by a model to help in the reduction in pollution from point sources. The type of the output of the model is:
   (a) stochastic (b) deterministic (c) predictive (d) functional

4. A system uses the Lagrangian puff model to analyze how the pollutant concentrations vary when the emissions change. The type of inputs of the model is:
   (a) static (b) dynamic (c) functional (d) predictive

5. Which of the following is part of developing the model but not part of converting your model into a computer model?
   (a) allocate memory to store the variables
   (b) tell the computer how one variable affects another
   (c) obtain input variables from the computer user
   (d) fix the parameters

6. Which of the following is needed during model calibration?
   (a) hypothesis (b) system boundary (c) field data (d) assumptions

7. In atmospheric modeling, which of the following is a terrain-following vertical coordinate system?
   (a) altitude coordinate system (b) pressure coordinate system
   (c) sigma coordinate system (d) rectilinear coordinate system

8. Considering the first-order decay of a pollutant, if initial concentration is 77 mg/m^3 and the rate constant is 0.4/day, what time will it take in days to reduce this concentration to 9.0 mg/m^3?
   (a) 0.9 (b) 5.4 (c) 2.1 (d) 6.5

9. In the Gaussian plume model, it is assumed that contaminants are reflected back into the atmosphere from the ground. For release height h, this is modeled by
   (a) using a virtual source at a height $z = -h$
   (b) using a virtual source at a height $z = h$
   (c) using a virtual source at a height $z = 0$
   (d) reducing the release height to $h/2$

10. The negative impacts of the emission from industrial stacks can be quantified by:
(a) box model (b) Green-Ampt model
(c) Topmodel (d) plume model

11. The methane emissions from paddy fields can be simulated by:
(a) Radiation model (b) Plume model
(c) Monod's kinetic model (d) Multimedia model

12. The infiltration process can be simulated by:
(a) Green-Ampt model (b) linear reservoir
(c) kinematic wave (d) box model

13. Which method is suitable for numerically solving an ODE?
(a) Streeter-Phelp (b) Richard's method
(c) finite-difference method (d) Darcy's method

14. From which model do you get the kinematic wave model?
(a) Darcy's model (b) Saint-Venant equation
(c) Tank model (d) Richard's equation

15. Where can you use models in the risk assessment?
(a) finding the distribution of a pollutant (b) designing a pollution control method
(c) find the number of pollutants (d) recycling the waste

16. If a source of pollution is surrounded by mountains and complex terrains, which model is the most suitable?
(a) 0-D model (b) 1-D model (c) 2-D model (d) 3-D model

17. In an environment system containing a pollutant, the fugacity of the system at equilibrium is 0.013 Pa and the fugacity capacity for soil is 11.5 $mol/m^3 \cdot Pa$. If the volume of the soil compartment is 8.6×10^5 m^3, find the moles of the pollutant in the soil.
(a) 1.7×10^{-7} (b) 0.00102 (c) 128570 (d) 760769230

18. In the sag curve of Streeter Phelps model, the concentration of dissolved oxygen recovers due to:
(a) reaeration (b) photosynthesis (c) DO deficit (d) fish population

19. Which of the following is used during the evaluation of a model?
(a) assumptions (b) flow sheets
(c) source code documentations (d) time-series plots

20. Which reactor model is applicable when the contents of the reactor have no spatial variation inside the reactor?
(a) CSTR (b) Batch (c) packed-bed (d) PFR

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SECTION "B"

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

1. When evaluating a model, how do you use the following analyses?
   (a) sensitivity analysis, and [3]
   (b) uncertainty analysis. [3]

2. While developing and using a spatially distributed application of a model to estimate the effects of extreme precipitation on soil erosion, answer the following:
   (a) Who is the end-user? [1]
   (b) What will the model do? [2]
   (c) How can the application guard against input error? [2]
   (d) What documentation is needed? [2]

3. Answer the following in the context of computer-based numerical modeling:
   (a) What are the arguments needed to use an ODE-solving function to simulate an environmental process? [2]
   (b) What are the main steps in plotting a time-series output from a model? [2]
   (c) How to you generate evenly spaced numbers over a specified interval? [2]

4. (a) In context of climate modeling, compare and contrast the Energy Balance Model and General Circulation Model. [4]
   (b) What is a terrain-following vertical coordinate system? [2]

5. (a) How do you use the tank model as a conceptual model in a hydrological model? [2]
   (b) How do you obtain Richard's equation from Darcy's law? [4]

6. Find the cumulative infiltration F after two hours of infiltration into a silt loam soil that initially had an effective saturation of 26 percent. Assume water is ponded to a small but negligible depth on the surface. For a silt loam soil, θ_e (effective porosity) = 0.55, ψ (wetting front soil suction head) = 14.2 cm, and K (hydraulic conductivity) = 0.62 cm/h. [6]
   Use the following relationship:

$$F(t) = K\,t + \psi\Delta\theta \ln\left(1 + \frac{F(t)}{\psi\Delta\theta}\right)$$

7. In a polluted city, the carbon monoxide concentration was measured as 19300 $\mu g/m^3$. The average mixing height during that time was 180 m, the wind was blowing at the speed of 1.1 m/s, and the background concentration of carbon monoxide was 4600 $\mu g/m^3$. The region is 8-km long and 4-km wide.
   (a) Estimate the emission rate per unit area of carbon monoxide in the city. [4]
   (b) If the wind speed is 1.1 m/s for 70% of the time, and for the rest of the time, the wind speed is 1.9 m/s at right angles, what will be the emission rate per unit area of carbon monoxide? [2]

8. A factory emits 210 g/s of SO_2 from a stack with height of 72 m and plume rise of 10 m. Wind speed at the effective emission height is 4 m/s. Calculate the SO_2 concentration at ground level 3.2 km downwind from the source at the plume centerline. Take the values of dispersion parameters σ_y = 120 m and σ_z = 43 m. [6]

9. (a) Explain the mass balance equation to model a completely mixed flow reactor. [3]
   (b) Using the process-based modeling technique, explain your strategy to model a municipal wastewater treatment plant. [3]