KATHMANDU UNIVERSITY
End Semester Examination [C]
December, 2024

Marks Scored:

Level : B.E.
Year : III

Course : CHEG 305
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 22 DEC 2024

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and encircle in the most appropriate option from each set of choices

1. Which type of problems has the outputs unknown but the inputs are known?
   a. rating b. design c. optimization d. deterministic

2. What is the most complex and highly difficult task in the modeling of a chemical engineering problem?
   a. interlinking of different scales of processes
   b. spatial dimension of domain
   c. uncertainty in input
   d. properties of chemical processes

3. Which of the following is the process of analyzing a whole process or a part of it, using the set of equations describing it?
   a. modeling b. sensitivity analysis
   c. simulation d. validation

4. Which model states that rate constant (k) is proportional to e^{-E}?
   a. Fick's first law b. Fick's second law c. Logistic model d. Arrhenius equation

5. Which one the following models is used in simulation of reactors that have no spatial variation of chemicals reacting inside the reactor?
   a. lumped model b. stochastic model
   c. distributed model d. population balance model

6. In which phase of model development do you use experimental data?
   a. process identification b. model validation
   c. model integration d. equation coding

7. Which one of the following Python function will you use to find the parameters of a model by using non-linear least squares?
   a. loglog b. fit_func c. params d. curve_fit

8. Which one of the following models is classified as a steady-state lumped model?
   a. CSTR b. Gaussian c. tanks in series d. PFR

9. Which phase is represented by a real root in Peng–Robinson EOS when two other imaginary roots are obtained?
   a. gas b. liquid c. solid d. liquid-gas

10. Which criteria is checked during numerical simulation of Navier-Stokes equation?
a. CFL b. gradient descent c. Adiabatic d. isothermal

11. Which simulation is a typical test to evaluate Navier-Stokes model in 2-D?
a. Lotka-Volterra b. Gaussian dispersion
c. cavity-lid d. Fluidized bed

12. Which model is capable of simulating the adsorption process in activated carbon?
a. Freundlich b. Burgers c. Ergun d. Monod

13. Which type of equation is necessary for developing an unsteady-state distributed model?
a. ODE b. PDE c. Linear d. DAE

14. What type of model is best suitable for simulating the flocculation for purifying drinking water?
a. population balance b. prey-predator
c. CSTR d. PFR

15. In which one of the following is partial derivatives used?
a. 1-D steady-state model b. black-box models
c. local sensitivity indices d. global sensitvity indices

16. What type of model is generally used to simulate the scenario in which you cannot easily interpret or explain the phenomena?
a. mechanistic b. empirical c. deterministic d. black-box

17. Which one of the following simulation can use a population balance model?
a. stack emission b. gas and liquid mixing
c. fluidized bed d. homogeneous reaction

18. What allows a network to introduce non-linearity into the ANN model?
a. activation function b. bias
c. backpropagation d. weight optimization

19. Which one is a Python library that contains functions to solve ODEs?
a. numpy b. scipy c. sympy d. pylab

20. In a feed-forward back propagation neural network, why are multiple hidden layers incorporated?
a. to handle big data b. to overcome overfitting
c. to minimize error in weights d. to learn complex patterns in data

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Course : CHEG 305
Semester : II
F. M. : 40

SECTION "B"
[40 marks]

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

1. In the field of modeling and simulation, describe the following with examples:
   a. Application of models in simulating fault detection in industries [2]
   b. Steps in the development of a model for chemical engineering [2]
   c. Importance of mechanistic modeling in chemical engineering [1]

2. Differentiate between the following types of models with an example of each: [2×3=6]
   a. Conceptual vs. process-based models
   b. Deterministic vs. stochastic models
   c. Lumped vs. distributed models

3. What is the importance of solving PDEs and ODEs in simulation of chemical engineering processes in the industries? If you are assigned to solve these two types of equations as a chemical engineer, what are the specific tools and techniques that you will use in Python programming environment? Explain with examples. [2+3]

4. Equilibrium isotherm data for adsorption of glucose from an aqueous solution to activated alumina are as follows: [6]

c	(g/cm^3)	0.004	0.0087	0.019	0.027	0.094	0.195
q	(g solute/g alumina)	0.026	0.053	0.075	0.082	0.123	0.129

   Determine the isotherm model that fits the data and provide the constants of the model.

5. How do you solve convection and diffusion equations through numerical equations in CFD modeling? Explain with the major steps involved in the modeling. [6]

OR

In a cement factory in Nepal, the stack gas analysis shows that 0.222 kg/s of carbon monoxide is being from a stack with height of 55 m. Due to the existing meteorological conditions, plume rise could be neglected. The wind is blowing at 5.2 m/s at the level of the stack's emission point. Using the Gaussian dispersion model, determine the concentration of carbon monoxide at ground level 3 km downwind from the source at the centerline of the path of emission. The following data were obtained from the reference graphs: dispersion parameter $\sigma_y = 150$ m and dispersion parameter $\sigma_z = 85$ m. [6]

P.T.O.

6. Regarding backpropagation neural networks, answer the following:
   a. Draw the schematic of the model. [1]
   b. How do you validate the model? [2]
   c. Explain an application of the model in chemical engineering. [3]

7. The column height of reacting mass in a reactor is modeled by $dC/dt = - kC^{2.2} + \omega v C^{1.2}$ where $\omega = (\pi D^3)/L^{1.5}$. D, L, and k are the constants related to the characteristics of the reactor. Assume $D = 1$, $L = 3$ and $k = 0.234$. If the nominal height of the reacting mass is 22 cm and assuming the steady state condition, determine and explain the following:
   a. the sensitivity of C by v. [4]
   b. the value of normalized sensitivity. [2]