Modeling and Simulation in Chemical Engineering Question bank Part-I
Department of Chemical Engineering

1. What is the mathematical model?
2. Write the names of software's available for mathematical modelling and simulation for chemical engineering applications. Discuss how they help and differ from each other in solving the problems.
3. Classify the mathematical model
4. Explain why modelling assumptions are important in building of a 'model'?
5. One of your friends writes down the inventory rate equation for money as

$$\begin{pmatrix} Change\ in\ amount \\ of\ rupees \end{pmatrix} = (Interest) - \begin{pmatrix} Service \\ charge \end{pmatrix} + \begin{pmatrix} Rupees \\ deposited \end{pmatrix} - \begin{pmatrix} Checks \\ written \end{pmatrix}$$

   Identify the terms in the above equation

6. Determine whether steady or unsteady state conditions prevail for the following cases (a). The height of water in dam during heavy rain (b). The weight of an athlete during a marathon (c). The temperature of an ice cube as it melts.
7. How to determine the rate of quantity interms of (i) Inlet/outlet rate (ii) Generation rate (iii) Accumulation rate.
8. Steady state transport without generation
9. Steady state transport with generation
10. Derive the total flux interms of Peclet number
11. Express (or) derive the mass flow rate of species 'i' entering or leaving the system in a mathematical form.
12. Explain the term "Peclet number" and its significance.
13. Recall the generalized form of molecular and convective flux of conserved quantities
14. The differential equation describing the time rate of change of water height is given by $\frac{dh}{dt} = 6 - 8\sqrt{h}$ Where, h is the height of water in meters. Calculate the height of water in the tank under steady conditions.
15. Dust evolves at a rate of 0.3 kg/ h in a foundry which has the dimensions of 20 m × 8 m × 4 m. According to ILO (International Labor Organization) standards, the dust concentration should not exceed 20 mg/ m^3 to protect workers health. Determine the volumetric flow rate of ventilating air to meet the standards of ILO.

16. Steam at a temperature of 200 °C flows through a pipe of 5 cm inside diameter and 6cm outside diameter. The length of the pipe is 30m. If the steady rate of heat loss per unit length of the pipe is 2W/m, calculate the heat fluxes at the inner and outer surfaces of the pipe.
17. Air at atmospheric pressure and 95 °C flows at 20 m/s over a flat plate of naphthalene 80 cm long in the direction of flow and 60 cm wide. Experimental measurements report the molar concentration of naphthalene in the air, C_A, as a function of distance *x* from the plate as follows:

x, (cm)	0	5	15	25	35	45
C_A, (mol/m^3)	0.117	0.105	0.085	0.069	0.057	0.047

Determine the molar flux of naphthalene from the plate surface under steady conditions by using least squares method. (Data: Diffusion coefficient of naphthalene (A) in air (B) at 25 °C = 0.62×10^{-5} m^2/s).

18. The geothermal gradient is the rate of increase of temperature with depth in the earth's crust. a) If the average geothermal gradient of the earth is about 25 °C/ km, estimate the steady rate of heat loss from the surface of the earth. Take the diameter and the thermal conductivity of the earth as 1.27×10^4 km and 3 W/ (m. K), respectively.
19. Air at 20 °C and 1 atm pressure flows over a porous plate that is soaked in ethanol. The molar concentration of ethanol in the air, C_A, is given by $C_A = 4\, e^{-1.5z}$. Where, C_A is in kmol/m^3 and z is the distance measured from the surface of the plate in meters. Calculate the molar flux of ethanol from the plate. Diffusivity of Ethanol in air is 1.1×10^{-6} m^2 /s.