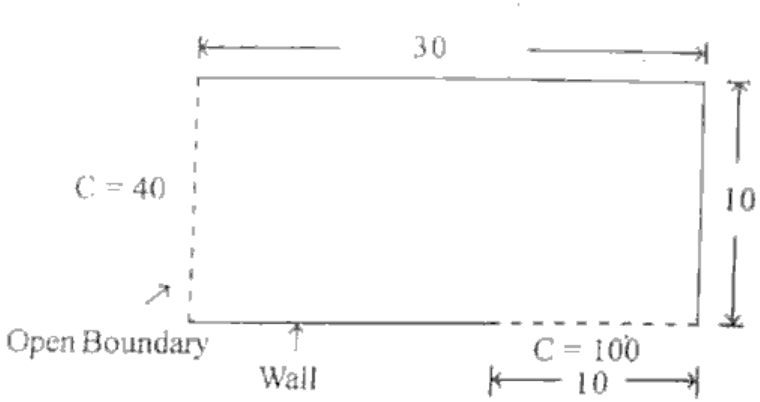
OR

10. Compute the steady state distribution of concentration for the tank shown in figure below. The PDE governing this system is

$$D\left(\frac{\partial^2 C}{\partial x^2}+\frac{\partial^2 C}{\partial y^2}\right)-kc=0$$

and the boundary conditions are as shown. Employ a value of 0.5 for D and 0.1 for k.

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# MECM - 105

## M.E./M.Tech., I Semester

Examination, December 2014

## Process Modeling and Simulation

*Time : Three Hours*

*Maximum Marks : 70*

*Note:* Attempt all questions, each carries equal marks.

1. a) Describe different steps of development of system simulation model.
   b) Based on mathematical structure give classification of different models.

OR

2. a) What is process analysis? Write down advantages, limitations and application of process analysis.
   b) What is the role of thermodynamic principles in modeling? Discuss.

3. a) Differentiate between dynamic lumped and distributed parameter models.
   b) What is dynamic programming? Explain its concept.

OR

4. Describe the modeling of isothermal chemical reactor with all necessary assumptions required. Show state variables input function and parameters using equations.

5. a) What are statistical models? Write the method of calibration and validation of statistical models.
   b) Explain grey box modeling. Show the strategies adopted for grey box modeling.

OR

6. a) Explain Empirical model building. What are the pros and

b) Given the following equilibrium data for the distribution of $SO_2$ in hexane, determine a suitable linear (in parameters) empirical model to represent the data

| x (pre, pri) | y(wt. fraction hexane) |
|---|---|
| 200 | 0.846 |
| 400 | 0.573 |
| 600 | 0.400 |
| 800 | 0.288 |
| 1000 | 0.209 |
| 1200 | 0.153 |
| 1400 | 0.111 |
| 1600 | 0.078 |

7. Solve the following pair of ODEs over the interval from $t = 0$ to $0.4$ using a step size of 0.1. The initial conditions are $y(0) = 2$ and $z(0) = 4$. Obtain your solution with:
   a) Euler's method and
   b) The fourth-order RK method.
   Display your results as a plot

OR

8. The growth of populations of organisms has many engineering and scientific applications. One of the simplest model assumes that the rate of change of population p is proportional to the existing population at any time $t$:

$$\frac{dp}{dt} = kg\,P$$

Where kg = the growth rate. The world population in millions from 1950 through 2000 was

| t | p |
|---|---|
| 1950 | 2555 |
| 1955 | 2780 |
| 1960 | 3040 |
| 1965 | 3346 |



| t | p |
|---|---|
| 1980 | 4454 |
| 1985 | 4850 |
| 1990 | 5276 |
| 1995 | 5686 |
| 2000 | 6079 |

a) Assuming that above equation holds, use the data from 1950 to 1970 to estimate kg.

b) Use the fourth-order RK method along with the results of part (a) to simulate the world population from 1950 to 2050 with a step size of 5 years.
   Display results on graph.

9. Use the control volume approach and derive the node equation for node (2, 2) in figure given below and include a heat source at this point. Use the following values for the constants: $\Delta z = 0.25$ cm, $h = 10$ cm, $k_A = 0.25$ W/cm.c, and $k_B = 0.45$ W/cm. c. The heat source comes only from material A at the rate of $= 6$ W/cm³.