TRANSPORT PHENOMENA

ENCH 303

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 0

Course Objectives:
The objective of this course is to provide concepts of the fundamental mechanisms governing the transport of momentum, energy, and mass, with emphasis on the use of shell balance and equations of change. By the end of the course, students will be able to analyze, evaluate, and design transport processes in engineering applications through rigorous problem formulation and solution.

1 Introduction and Momentum Transport (4 hours)

1.1 Levels of transport phenomena and conservation laws
1.2 Molecules to continuum
1.3 Convective and molecular momentum flux tensor
1.4 Total momentum flux

2 Shell Momentum Balances and Velocity Distributions (4 hours)

2.1 Shell balances and boundary condition
2.2 Flow of a falling film
2.3 Flow through a circular tube and an annulus
2.4 Flow of two adjacent immiscible fluids

3 Equation of Change for Isothermal Systems (6 hours)

3.1 Equation of continuity and motion
3.2 Equations of change for mechanical energy
3.3 The equation of change (Substantial derivative form)
3.4 Common simplifications of equation of motion
3.5 Solving problems with one independent variable

4 Mechanism of Energy Transport (4 hours)

4.1 Conductive and convective energy-flux vector
4.2 Work and total energy flux vector
4.3 Thermal conductivity of gases, liquids, solids and composite solids

5 Shell Energy Balances and Temperature Distributions (4 hours)

5.1 Shell energy balances and boundary conditions
5.2 Heat conduction in a steam pipe, composite wall and cooling fin
5.3 Energy transport with energy production
5.4 Forced convection
5.5 Free convection

6 Equations of Change for Non-Isothermal Systems (6 hours)

6.1 Energy equations and special forms
6.2 Boussinesq equations for free and forced convection
6.3 Equations of change and one independent variable problem

7 Mechanism of Mass Transport (4 hours)

7.1 Species concentrations, mass and molar flux vectors
7.2 Diffusive mass and molar flux vectors – Fick's law
7.3 Total mass and molar flux vectors
7.4 Diffusivity and principle of corresponding states
7.5 Diffusivity of gases

8 Shell Mass Balance and Concentration Distribution (8 hours)

8.1 Shell mass balances and boundary conditions
8.2 Diffusion through solids and away from slightly soluble sphere
8.3 Diffusion in homogeneous and heterogeneous chemical reaction
8.4 Diffusion through a stagnant gas film
8.5 Diffusion of gases in a two-bulb experiment
8.6 Diffusion into a falling liquid film
8.7 Diffusion and reaction inside a porous catalyst

9 Equations of Change for Binary Mixtures (3 hours)

9.1 Continuity equation for binary mixture
9.2 Binary mixtures conservation laws and molecular fluxes
9.3 Equations of change and steady state problems
9.4 Unsteady state diffusion problems

10 Multicomponent Macroscopic Balances (2 hours)

10.1 Macroscopic mass and energy balance
10.2 Macroscopic mechanical energy balance
10.3 Solving steady state problems

Tutorial (15 hours)

1. Shell momentum balance
2. The equation of change for isothermal system
3. Shell energy balance

4. The equation of change for non-isothermal system
5. Shell mass balance
6. The equation of change for binary mixtures

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1 and 2	8	12
3 and 4	10	14
5 and 6	10	14
7 and 8	12	14
9 and 10	5	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Bird, R. B., Stewart, W. E., Lightfoot, E. N., Klingenberg, D. J. (2015). Introductory transport phenomena. Wiley.
2. Bird, R. B., Stewart, W. E., Lightfoot, E. N. (2007). Transport phenomena (Latest Edition). Wiley.
3. Deen, W. M. (2012). Analysis of transport phenomena. Oxford University Press.
4. Thomson, W. J. (2000). Introduction to transport phenomena (Latest Edition). Prentice Hall.
5. Welty, J. R., Rorrer, G. L., Foster, D. G. (2024). Fundamentals of momentum, heat and mass transfer. John Wiley & Sons.