

Objective: To introduce governing relations of momentum, heat, and mass transfer, application shell balance technique, application of transport equations through microscopic balances of momentum, thermal energy, and mass species.

Credits Earned: 4 Credits

Course Outcomes: After completion of this course, student will be able to:

- Setup overall balances for conservation of momentum, energy and mass.
- Recognize and apply analogies among momentum, heat and mass transfer.
- Reduce and solve the appropriate equations of change to obtain desired profiles for velocity, temperature and concentration.
- Utilize information obtained from solutions of the balance equations to obtain Engineering quantities of interest.
- Reduce and solve appropriate macroscopic balances for conservation of momentum, energy and mass.

Pre-requisite of course: A course on Fluid Flow Operation, Process Heat Transfer, Mass Transfer Operation and Vector Calculus.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	CSE	Internal (I)	Viva (V)	Term work (TW)	
3	2	0	4	50	20	30	25	25	150

Contents:

Unit	Topics	Contact Hours
1	Introduction to Transport Phenomenon: Classification of Transport Processes, Conservation Laws, Vector and Tensor Calculus	6
2	Principles of Momentum Transport: Concept of Viscosity, Newton's Law of Viscosity, Shell Momentum Balance, Application of Shell Momentum Balance, Flow of Falling Film, Flow Through Circular Pipe, Flow Through annulus, Flow Over Moving Plate, Couette Viscometer, Equation of Changes: Continuity Equation, Equation Motion, Navier-Stokes Equation in Cartesian Co-ordinate's and Cylindrical Co-ordinate, Basics of Velocity Distribution	12

3	Principles of Steady State Heat Transport: Steady State Condition and Fourier's Law, Shell Energy Balance, Applications of Shell Energy Balance: Heat Conduction with Electrical Source, Heat Conduction with Chemical Heat Source, Temperature Distribution in Two Concentric Cylinder's, Natural Convection Heat Transfer Governing Equation, Flow over Flat Plate	12
4	Principles of Mass Transport: Equation of Molecular Mass Transport, Molecular Diffusion in Gases, Equimolar Counter Diffusion, Diffusion of A through Non-Diffusing B, Mass and Molar Transport by Convection: Mass and Molar Concentrations, Mass Average and Molar Average Velocity, Molecular Mass and Molar Fluxes, Convective Mass and Molar Fluxes	8
Total Hours		38

List of Tutorials:

1. Flow of Falling Film
2. Flow Through Circular Pipe
3. Flow Through annulus
4. Flow Over Moving Plate
5. Heat Conduction with Electrical Source,
6. Heat Conduction with Chemical Heat Source
7. Flow over Flat Plate
8. Diffusion through stagnant film

Reference Text Books:

- R. Byron Bird, "Transport Phenomena", 2nd Edition, John Wiley & Sons (Asia) pvt. Ltd.
- Christie John Geankoplis, "Transport Processes and Separation Process Principles", 4th Edition, PHI Learning Private Limited., New Delhi
- Incropera, "Fundamentals of Heat and Mass Transfer", 6th Edition, John Wiley & Sons (Asia) pvt. Ltd.
- W.J.Thomson, "Introduction to Transport Phenomena", Pearson Education Asia, New Delhi, 2001.

Suggested Theory distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory marks					
Remember	Understand	Apply	Analyze	Evaluate	Create
10%	25%	30%	15%	10%	10%

Instructional Method:

- a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
- b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
- c. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.

**Syllabus for Bachelor of Technology
Chemical Engineering**