**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**
**HYDERABAD CAMPUS**
**First Semester 2020-2021**
**Course Handout (Part-II)**

**Date: 17/08/2016**

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : **CHE F414**
Course Title : **Transport Phenomena**
Instructor-in-charge : **Dr. Vikranth Kumar Surasani**

**Course Description**:
Analogy among momentum, heat and mass transport phenomena; Shell balance approach for all three transport phenomena, Boundary layer concepts, velocity, temperature and concentration distribution in laminar flow; Velocity distributions in turbulent flow.

**Scope and Objective of the Course**:
Transport phenomena are a subject of importance both in science and engineering. All the three transport mechanisms such as momentum, heat and mass transfer frequently occur in chemical processes either individually or simultaneously. The aim of this course is to feel the physics of the process and then use the knowledge of the transport phenomena to represent the process behavior. Finally the aim is to analyze a few real life problems to understand the complexity of the chemical processes in view of three transport mechanisms.

**Books:**
Text Book
1. Bird, Stewart and Lightfoot, 'Transport Phenomena', John Wiley & Sons, 2002, 2nd edition

Reference Books
1. Fox and McDonald, 'Introduction to fluid dynamics,' John Wiley & Sons, 2008, 7th edition
2. Holman, J.P., 'Heat transfer', McGraw Hill, 1997, 8th edition

**Course Plan:**

| Lecture No. | Learning Objectives | Topics to be covered | Text Book Chap./Sec |
|---|---|---|---|
| 1 | Introduction | Scope and objectives of course, methodology | Ch. 0 |
| 2 - 3 | Molecular momentum transport | Newton's law and molecular theories of viscosity | 1.1-1.5 |
| 4 | Convective momentum transport | Convective momentum transport | 1.7 |
| 5 | Momentum balances | Shell momentum balances, boundary conditions | 2.1 |
| 6 - 8 | Velocity distributions in laminar flow | Examples | 2.2-2.5 |
| 9 | Equations of change for isothermal systems | Equations of continuity, motion and mechanical energy | 3.1-3.3 |
| 10 - 11 | Applications of equations of change | Examples | 3.5-3.6 |
| 12 | Applications of equations of change | Dimensional analysis | 3.7 |
| 13 | Velocity distributions | Time-dependent flow of Newtonian | 4.1 |

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|---|---|---|---|
| | with more than one independent variables | fluids | |
| 14 - 15 | Stream functions and velocity potential | Solving flow problems using stream functions and velocity potential | 4.2-4.3 |
| 16 | Flow near solid surfaces | Boundary layer theory | 4.4 |
| 17 | Turbulent flow | Time-smoothed equations of change and velocity profiles | 5.1-5.3 |
| 18 - 19 | Velocity distributions in turbulent flow | Empirical expressions for turbulent momentum flux; turbulent flow in ducts etc. | 5.4-5.6 |
| 20 | Molecular energy transport | Fourier's law of heat conduction, molecular theories of thermal conductivity | 9.1-9.6 |
| 21 | Convective energy transport | Convective transport of energy, work associated with molecular motions | 9.7-9.8 |
| 22 - 23 | Energy balances | Shell energy balances, examples | 10.1-10.7 |
| 24 | Convection | Forced and free convection | 10.8-10.9 |
| 25 | Equations of change for non isothermal systems | Various forms of energy equations | 11.1-11.3 |
| 26 - 27 | Applications of equations of change | Examples | 11.4 |
| 28 | Applications of equations of change | Dimensional analysis | 11.5 |
| 29 - 30 | Temperature distributions with more than one independent variable | Unsteady state heat conduction in solids and in laminar flow | 12.1-12.3 |
| 31 | Boundary layer theory | Boundary layer theory for non-isothermal flow | 12.4 |
| 32 | Molecular mass transport | Fick's law of binary diffusion, molecular theories of diffusion | 17.1-17.6 |
| 33 | Convective mass transport | Mass and molar transport by convection, summary of mass and molar fluxes | 17.7-17.8 |
| 34 | Mass balances | Shell mass balance, boundary conditions | 18.1 |
| 35 - 37 | Concentration distributions in solids and laminar flow | Examples | 18.2-18.7 |
| 38 | Equations of change for multicomponent systems | Equations of continuity, summary of multicomponent equations of change | 19.1-19.3 |
| 39 | Applications of equations of change for multicomponent systems | Examples/Dimensional Analysis | 19.4 |
| 40 - 41 | Temperature distributions in turbulent flow | Time-smoothed equations of change and temperature profiles for turbulent flow in tubes | 13.1-13.4 |

**Evaluation Scheme**:

| EC No. | Evaluation Component | Duration | Weightage (%) | Date & Time | Nature |
|---|---|---|---|---|---|
| 1 | Test I | 30 min | 10 | September 10 –September 20 (During scheduled class hour) | OB |
| 2 | Test II | 30 min | 15 | October 09 –October 20 (During scheduled class hour) | OB |
| 3 | Test III | 30 min | 15 | November 10 – November 20 (During scheduled class hour) | OB |
| 4 | Class Quiz | | 10 | | OB |
| 5 | Assignments | | 15 | | OB & Matlab |
| 5 | Comprehensive Exam | 3 hrs | 35 | | OB |

**Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable

**CAD Lab Practice Hours:** 5-8 pm (All days)

**Chamber Consultation Hour:** 5-5:30 pm (Mon, Wed, Friday)

**Notices:** All notices concerning this course will be displayed on the Chemical Engineering Notice Board and Course Management System (CMS) portal.

**Make-up Policy:** Make-up is granted only for genuine cases having 75 % attendance with valid justification. A prior permission from the Instructor-in-charge is required.

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**Instructor-in-charge**
**(CHE F414)**