# BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI, K. K. BIRLA GOA CAMPUS
## INSTRUCTION DIVISION
## SECOND SEMESTER 2018-2019
### Course Handout Part II

**Date: 08-01-2019**

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

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| **Course No.** | : **CHE F244** |
| **Course Title** | : **Separation Processes I** |
| **Instructor-in-charge** | : **Dr. S. S. Baral** |
| **Instructor (Tutorial)** | : **Dr. S. S. Baral/ Rhea Mariam John** |

### 1. Scope and Objective of the Course:

The Separation Processes are widely used in chemical industries. To design a mass transfer equipment, basic knowledge of mass transfer operations, cascades design etc. are required. An essential aspect of this study is to understand how the fundamentals of diffusion, mass transfer etc. can be applied for design purposes.

### 2. Text Books:

T1. R. E. Treybal -Mass Transfer Operations MGHISE, 3rd ed., 1980.

T2. W.L. Mccabe, J.C. Smith and P. Harriott- Unit Operations of Chemical Engineering, Mc Graw Hill Co. 6th ed., (2001)

**Reference Book:**

Foust, Wenzel, Clump, Anderson-Principles of Unit Operations, John Wiley and Sons, 2nd Ed., 1980.

### 3. Course Plan

| Lectur No. | Learning Objectives | Topics to be covered | Reference* Chap./Sec.# (Book) |
|---|---|---|---|
| 1 | Introduction to mass transfer operations | The processes with V, L & S Phases | Chap.1, T1 |
| 2, 3 & 4 | Molecular diffusion | Molecular diffusion and fluxes. Molecular diffusion in Gases (stagnant film, equimolal counter diffusion). Diffusivity of gases and liquids | Chap.2, T1 |
| 5 | Molar fluxes for gases and liquids in terms of mass transfer coefficients | Mass transfer coefficients and relations between mass transfer coefficients. | Chap. 3, T1 |
| 6-7 | Equilibrium distribution in interphase mass transfer | Interphase mass transfer, equilibrium, diffusion between phases, local two phase mass transfer | Chap. 5, T1 |
| 8 | Concept of overall mass transfer coefficient and controlling step | Local overall mass transfer coefficients, controlling step in overall process | Chap. 5, T1 |
| 9-10 | Generalized individual and overall mass transfer coefficients | Local coefficients-General case | Chap. 5, T1 |
| 11 | Operating lines for co-current and counter current operations (G→L & L→G) | Steady state co-current processes. Steady state counter-current processes | Chap. 5, T1 |
| 12-13 | Concept of stage & cascade, no. of stages for cross current and counter current flows | Stages, cascades, cross flow cascades, counter current cascades. | Chap. 5, T1 |

| 14. | Introduction to absorption process, equilibrium solubility of gases in liquids | Equilibrium solubility of gases in liquids, (Two component and multi component systems, ideal and non-ideal systems) | Chap. 8, T1 |
|---|---|---|---|
| 15,16 | Solvent selections, operating line equations for absorption and stripping for cocurrent and countercurrent flow, calculation of no of stages using graphical methods and using kremser equation | Choice of solvent for absorption, one component transfer: material balance for counter - and co-current processes, multi stage operations. | Chap. 8, T1 |
| 17. | No of stage calculations for non-isothermal process | Non- isothermal operations | Chap. 8, T1 |
| 18, 19 &20 | Calculation of height of packed absorber / desorber using $N_{tG}$, $H_{Tg}$, $N_{toG}$, $H_{toG}$, $N_{tL}$, $H_{tL}$, $N_{toL}$, $H_{toL}$ for dilute and normal solutions and only one component is absorbed / desorbed | Continuous contact equipment, overall coefficient and transfer units, dilute solutions (Henry's law), graphical construction of transfer units. | Chap. 8, T1 |
| 21 | VLE in distillation calculation and concept of relative volatility | Distillation, vapor - liquid equilibrium, relative volatility, increased pressures, ideal solutions | Chap. 9, T1 |
| 22, 23 | P-x-y & T-x-y diagrams for non-ideal solutions (positive and negative deviations from ideality) | Positive deviations from ideality, minimum-boiling mixtures, Partial liquid miscibility; insoluble liquids, steam distillation. Negative deviations from ideality, maximum-boiling mixtures. Differential distillation. Flash distillation | Chap. 9, T1 |
| 24 | Overview of continuous distillation | Continuous distillation, multi-stage columns, overall mass and enthalpy balances | Chap. 21, T2 |
| 25-26 | McCabe-Thiele method for continuous distillation | Assumptions; Material balances in plate columns, no. of ideal plates (McCabe-Thiele method), reflux ratio, condenser and top plate, bottom plate and reboiler. | Chap. 21, T2 |
| 27-28 | Qualitative discussion on feed plate, equation of feed line, construction of operating lines for top and bottom sections and calculation of no. of plates | Feed plate, feed line, construction of operating line, feed plate location, | Chap. 21, T2 |
| 29 | Effect of reflux ratio on no. of plates, calculation of minimum no. of plates and minimum reflux ratio, Fenske equation for minimum no. of plates. | Minimum no. of plates, minimum reflux, invariant zone, optimum reflux. | Chap. 21, T2 |
| 30 | Enthalpy concentration diagram and ratio rule | Enthalpy concentration diagrams and its characteristics. | Chap. 9, T1 |
| 31-32 | Ponchon Savarit Method | Ponchon Savarit method, Mass & enthalpy balances around individual stages; enriching & stripping sections, minimum and total reflux, calculation of no. of stages, condenser & reboiler duties | Chap. 9, T1 |

| 33-34 | Calculation of no. of plates for multiple feeds, open steam and side product | Use of open steam, multiple feed, side streams. | Chap. 9, T1 |
|---|---|---|---|
| 35 | Typical difficult cases of distillation | Rectification of azeotropic mixtures; Azeotropic & extractive distillations | Chap. 9, T1 |
| 36-40 | Liquid extraction | Liquid-liquid equilibrium, distribution curves, triangular and solvent free coordinates, systems of three liquids-one pair partially soluble, insoluble liquids, effect of temperature, continuous counter-current multi-stage extraction, continuous counter-current extraction with reflux. | Chap. 10, T1 |
| 41-42 | Leaching | Solid-liquid extraction, underflow and overflow locus, Multistage cross current extraction, Calculation of no. of stages for cross current flow. | Chap.13, T1 |

3. **Evaluation Scheme:**

| EC no. | Evaluation component | Duration (min) | Weightage (%) | Date and time | Nature of component |
|---|---|---|---|---|---|
| 1 | Mid-Semester Examination | 90 | 30 | 14.03.19, 4-5.30 PM | Closed Book |
| 2 | Surprise Quizes/ Assignements & Attendance | | 30 | | Open Book |
| 3 | Comprehensive examination | 180 | 40 | 09.05.19 (FN) | Closed / Open Book |

4. **Chamber Consultations Hour:** To be announced in the Class.
5. **Make-up Policy:** Make-up will be granted for student having genuine reasons for not appearing in the regular test.
5. **Notice:** All Notices will be in the course moodle

Instructor     In-charge