

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
INSTRUCTION DIVISION
FIRST SEMESTER 2016-2017
Course Handout (Part II)

Date: 27/07/2016

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 F211**
Course Title : **Chemical Process Calculations**
Instructor-in-charge : P C Sande
Tutorial Instructor : A K Pani, P C Sande

1. Scope & Objective of the Course:

This course is designed for the beginner in the field of chemical engineering. It deals with calculations which form the basis of the design of a chemical industrial plant or process. It aims to inculcate systematic and sound problem solving skills in the student. The macroscopic and continuum view of matter is assumed. Material and energy balances are introduced, explained and worked with. The problems solved are prototypes of real process plants. Fundamentals of this course are required in other courses such as Chemical Reaction Engineering, Separation Processes and Process Modelling and Simulation.

2. Text Book:

Himmelblau, D. M and Riggs, J.B. "Basic Principles and Calculations in Chemical Engineering", PHI, 7th ed., 2009.

3. Reference Book:

B. I. Bhatt, S. M. Vora, "Stoichiometry", Tata McGraw-Hill Pub. Co., 4th ed., 2004.

4. Course Plan:

| Lecture No. | Learning | Topics to be covered | Ref. Chapters (Text Book) |
|-------------|---|--|---------------------------|
| 1 | Realize industrial relevance of process calculation. Revise units and conversion factors. | Importance of process calculations in chemical industry, Units and Dimensions, Conversion of units, Dimensional consistency | 1.1-1.4 |
| 2 | Review preliminaries. | Diagnostic test on units and dimensions [#] . The mole, density, specific gravity, flow rate, mole and mass fraction, multi-component solution and mixtures, concentration | 2 |
| 3 | Important definitions | Temperature, Pressure, Significant figures, choosing a Basis, | 4, 5, 1.5, 3 |
| 4-6 | Material Balance preliminaries | Open Vs Closed systems, Steady Vs Unsteady state systems, Multi component systems, Systems with chemical reactions, Problem solving strategy, solution validation, Industrial example (out of text book) | 6, 7, 1.6 |
| 7 | Material Balance for Single Unit | Material Balance Problems without Chemical Reaction | 8 |
| 8 | Chemical Reaction Stoichiometry | Stoichiometry and Its Terminology | 9 |
| 9-10 | Material Balances with Chemical Reaction | Material Balance Problems with Chemical Reaction: species, elemental and combustion | 10 |
| 11-12 | Material balances involving multiple subsystems | Material balance problems involving multiple subsystems | 11 |

| | | | |
|-------|--|---|--------------|
| 13-14 | Material balances with recycle, bypass and purge | Recycle bypass and purge calculations | 12 |
| 15 | ideal gas Vs real gas systems | Ideal gas law calculations, ideal gas mixtures and partial pressure, real gas compressibility | 13, 14 |
| 16-17 | Vapor pressure and saturation, calculation of dew point | Real gas equations of state (only main concept), Phase diagram, vapor pressure estimation, saturation, condensation, vaporization | 15, 16, 17 |
| 18-19 | Definition of partial saturation | Partial saturation and humidity | 18 |
| 20-21 | Humidity chart | Terminology, properties from humidity chart | 29 |
| 22 | Energy balance preliminaries | Terminology, Types of Energy, Energy balance for: Closed system (steady and unsteady), Open system (steady and unsteady) | 21,22 |
| 23-24 | Calculation of enthalpy changes, use of equations and tables | Calculation of enthalpy changes, heat capacity equations, Research Assignment | 23 |
| 25-26 | Enthalpy balances | Energy balances in the absence of chemical reactions | 24 |
| 27-28 | Energy balance with chemical reaction | Heat of formation, Heat of Reaction, heat of combustion | 25 |
| 29-31 | Solving simultaneous material and energy balances | Analysis of the degrees of freedom, solving material and energy balances simultaneously | 26 |
| 32-34 | Presentation of Research Assignments | The best research assignments will be assessed and presented. | Class ppt. |
| 35-36 | Heats of solution and mixing | Heat of solution, dissolution and mixing | 28 |
| 36-40 | Revision | Problem solving | All chapters |

5. Evaluation Scheme:

| Components | Duration | Marks (Weight age) | Date and Time | Remarks |
|--|----------|---------------------|---------------|---------|
| Mid Semester Test | 90 min | 90 (30%) | <TEST_1> | CB/OB |
| Beginner's test [#] , Tutorial Tests [*] | 10 min | 4+ (8×6) = 52 (17%) | | CB |
| Research paper Assignment ^s | | 18 (6%) | | OB |
| Comprehensive Examination | 3 hours | 140 (47%) | <TEST_C> | CB/OB |

[#] This is an announced test to be held in the second lecture class. This beginner's test will be for 4 marks and will have no 'best of' option. It will cover units, conversions and dimensions.

^{*} Tutorial tests will be surprise in nature. All tests will be conducted in the tutorial hours, unless otherwise announced in class, and will be of 8 marks each. Best six performances (out of 8) will be considered. To avoid having assignment and tutorial tests towards the end, more number of tutorial tests will be conducted before mid-semester. **No make-up for tutorial tests for any reason since 'best of option' is provided.**

^s This component is research oriented and will be announced and guided. There is no best of option for this component. Assignment *must* be submitted on or before the due date (to be announced in class). late submission by one day will entail 30% less marks, and this will increase by 20% with each passing day.

6. Make-up Policy:

Make-up for Mid-sem will be granted only in case of illness justified by warden of the respective bhavan with accompanying medical certificate. **Only medical certificate will NOT be considered.** Make-up for comprehensive examination must be obtained from ID.

7. Chamber Consultation Hour:

To be announced in the class.

8. Notices: all announcements will be made in class only.

Instructor-in-charge
CHE F211